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PAPER NO. XI.

STATE OF AGRICULTURE.

STATE OF AGRICULTURE.

INTRODUCTION.

GENERAL ASPECT.

Agriculture, the chief source of wealth and prosperity, the inseparable companion of the well-being of families and of the power of States, this branch of production, most intimately allied with the lot of the people, has not prospered in the Philippines as was to be expected, in view of the favoring conditions which exist in the soil and vegetation of the virgin land, which assist in the solution of such a great problem. In effect, the insular tropical climate of the Philippine Archipelago, with the various modifications of it caused by the topographical situation— the humid atmosphere on the one hand, and the diversity of soils due to mineral constituents and effluvial matter on the other hand, and finally the great wooded regions which have deposited upon the land during ages a thick coating of organic matter, a most desirable fertilizer of the soil— all this constitutes a union of conditions which make the Philippine land able to produce and multiply not only the productions of tropical climates, but also many others of temperate zones, if proper measures are taken.

For what reason is it, then, that the actual conditions do not correspond to such dispositions? The poorly developed agricultural condition is due to several causes. We will enumerate briefly the principal ones in the first of the three following chapters into which this part is divided. In the second chapter we will indicate the actual present condition of Philippine agriculture, and finally, in the third, we will consider certain means of improvement.

CAUSES OF THE SLIGHT DEVELOPMENT IN AGRICULTURE IN THE PHILIPPINES.

SMALL POPULATION.

One of the first requisites for the cultivation of land, without which it is not possible to develop the soil in a rational manner, is the hand of man, and human labor must stand in harmony with all the other agents of production. The worthy cultivation of the soil is not possible if there is a lack of hands for the multifarious labors. This condition has existed in the Philippines. There has existed no proper proportion between its scanty population and the immense area of its territory. In 1810, by approximate computation, there existed in the archipelago 2,526,000 inhabitants. Among them were Chinese mestizos, 119,000; Chinamen, 7,000, and those of the white race did not exceed 4,000. As a matter of fact, but one-ninth part of the whole territory—3,267,000 hectars—was cultivated. Bearing in mind that the extent of Philippine territory is nearly equal to that of Italy, with 28,000,000 inhabitants; a little less than that of England and Ireland, with 32,000,000 inhabitants, and six times that of Belgium, with 5,000,000 inhabitants, the condition of the Philippines is conspicuous, presenting a virgin soil and an extensive territory to a population of scarcely 8,000,000.

SLIGHT ACTIVITY OF THE NATIVE RACE.

If, in connection with the scanty population, is taken into consideration the character of the Indian, it will be seen that the proverbial laziness of the native race has been no slight obstacle to advancement in agriculture, as in other directions. Content, as they are, with the most limited amount for sustenance, which, as a rule, they are able to gain without effort, they do not apply themselves to work and have none of the more lofty ambitions. They care naught for the morrow nor for leaving to their children and their heirs the means for enjoying a happy future. While there are honorable and frequent exceptions, increasing in number every day, it is none the less a fact that in general they refuse to eat bread won by the sweat of the brow, and this in spite of the fact that it is to agriculture the Filipino owes all there is of value in the general traffic of the islands; for, without taking into account the large interisland traffic and consumption of prime agricultural products, 90 per cent of its exportation, which exceeds 36,000,000 pesos annually, is composed of a few leading products of the soil upon which but little handiwork is spent, even in the case of manufactured tobacco. Indeed, up to the present time there exists no considerable branch of exportation which does not come from the vegetable kingdom, obtained in the first instance by field labor.

THE LACK OF WAYS OF COMMUNICATION.

No one is ignorant of the great advantages which means of communication afford to agriculture. It is indeed one of the chief conditions for the development of agriculture, if there is any pretense of seeking rich results from it. Unfortunately, in the Philippines there are scarcely known other ways than the so-called general highways, and these in certain periods of the year are little less than impassable. Nor are there byways or anything deserving this name in the great majority of districts. Such byways, or secondary roads, are essential means of communication in agricultural districts; and for the farmer it is a necessity to be able to transport, without the destruction of his beasts of burden, the products of his lands to the markets where they will find best sale. ✓ Because of the lack of such ways of communication it results that the districts produce only that required for their own subsistence, leaving stationary the general march of agriculture and abandoning the elements of production which natural opportunity provides in a country naturally as fertile as the Philippines. ✓

FAILURE TO TAKE ADVANTAGE OF THE WATER OF RIVERS.

A multitude of rivers, large and small, pass through the lands of the archipelago. They run along their great beds without, however, inundating their boundaries and fertilizing the country. With very

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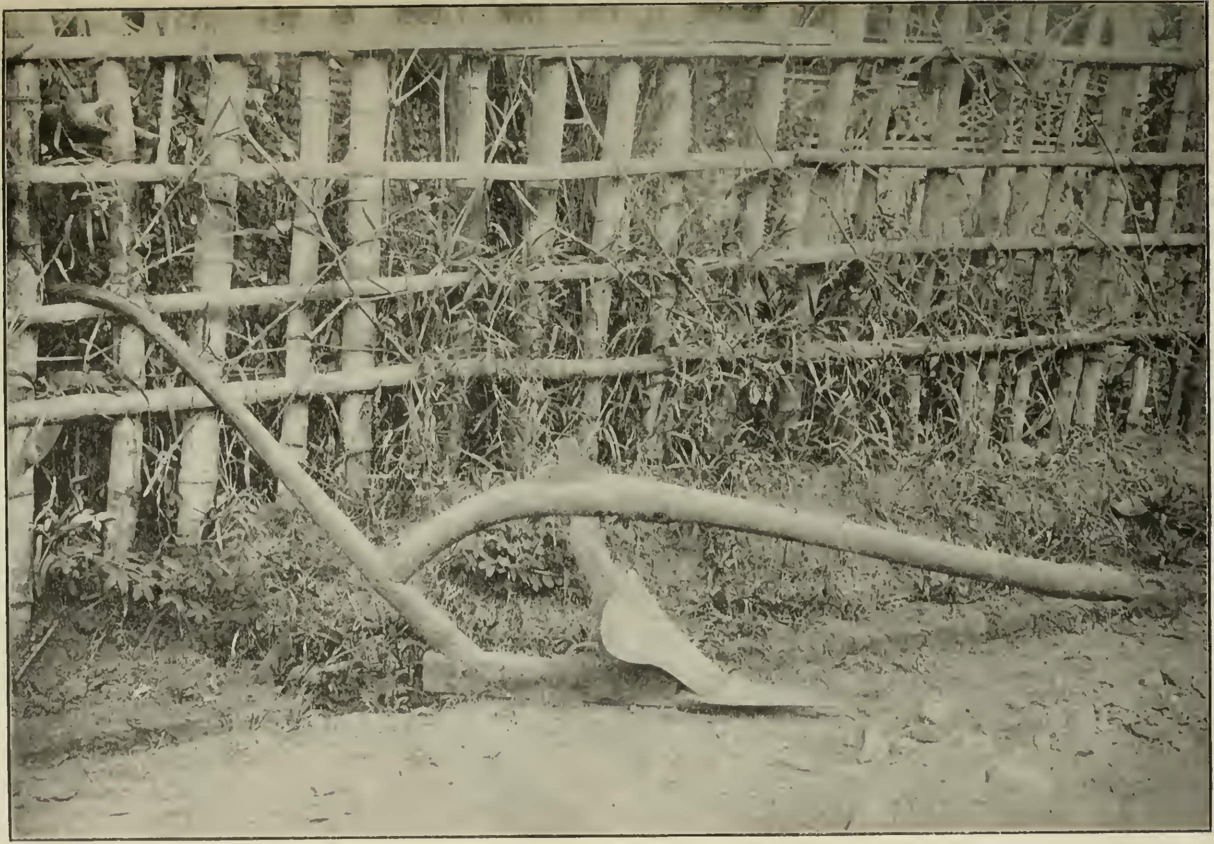


A NATIVE PLOW.

slight cost, however, in many places they can be diverted and run into small canals, irrigating extensive tracts, which at the mouths of these rivers stand awaiting this kind of fertilization, thus transforming barren plains into beautiful and productive fields, in which can be raised a great number of plants that will greatly augment the wealth of the country. Many districts now lose crops and suffer hunger in consequence of drought because trusting solely to the water of rains, while having, nevertheless, in the neighborhood rivers which easily would furnish not only water for irrigation, but also fertilizing matter which they always hold in greater or less quantities. To a still less extent has the country taken advantage of the great power of flowing water as a motive force for the simple machinery used in production. In many rivers there are falls of water which, in addition to serving as irrigation for the district, could, with small cost, be turned to remunerative industrial development.

IMPERFECTION OF AGRICULTURAL IMPLEMENTS.

The poor state of production in which the archipelago stands with relation to other countries depends further upon the deplorable systems of cultivation followed by its farmers. In the Philippines there is scarcely known, much less employed, a single one of the thousand well-perfected agricultural machines, the use of which in other countries is general, even among agriculturists least skillful. By reason of this all work is done in an imperfect manner, because in no other manner can work be done with the antiquated implements which are here used.

LACK OF CAPITAL.

The lack of proper capital and the high price asked for loans constitute another obstacle, which stupefies industry, augments the cost of production, and restrains, in consequence, its benefits. In order to till the soil capital is necessary, if not indispensable, and often can be reimbursed only at the end of years.

HAPHAZARD METHODS.

Vicious also is the general system of agriculture adopted and followed in this country. It neither suits the necessities of its inhabitants, much less nourishes and furthers commerce and industry, nor does it take proper advantage of the happy combination of soil, climate, and good distribution of waters which are at hand. The unenlightened method of cultivation of the fields employed is purely brutal; it being recognized that to till the soil, with proper fruit, there is more need of work with the head than with the hands. In a word, there is in the archipelago no system of agriculture, properly so called, and the greater part of the people have no idea of what agriculture really means. In a land like the Philippines, in which in every direction there grow spontaneously plants of commercial and industrial value, and of the best quality, how easy it would be to subject them to a cultivation which would greatly improve and proportion the products to a greater number of industries, which would give occupation to many hands in addition to those directly employed in agriculture. By the side of the agricultural population there would then grow up an industrial population which could make use of the products of the soil and in turn be a consuming class.

CONSEQUENCES.

To the defects enumerated is to be attributed the fact that the Philippines so long remain in the primitive agricultural condition in which, according to economists, the country produces only that which is strictly necessary for its own meager sustenance. The defects spoken of in the agricultural system lasted down to the time of Governor-General Basco, who, in 1782, decreed in certain provinces a monopoly and an enforced cultivation of tobacco, inaugurating by this scarcely equitable measure the agricultural progress of the country.

FUTILE EFFORTS OF THE ROYAL COMPANY OF THE PHILIPPINES.

Coincident with the decree above mentioned was established the Royal Company of the Philippines, with a large capital raised in Spain. Its principal object was to establish upon a large scale proper mercantile relations between the archipelago, East India, China, and the Spanish-American colonies. The business with the last-named countries consumed, however, a great amount of the capital and the greater part of the activities in the development of the agriculture of the archipelago. To this is due the attempts made to develop on a large scale the cultivation of cotton, pigments, cloves, cinnamon, coffee, cocoa, and the mulberry tree for the growing of the silkworm, and other products of the soil. But the general apathy that came, the lack of technical knowledge on the part of subordinates, the privileges granted to shippers from Acapulco in hostility to those of the company, and, lastly, the strange privileges in business, amounting to a tacit, if not expressed, monopoly, conceded to the provincial governors, which lasted down to the year 1844, together with other causes, such as general backwardness and ignorance and the mercantile isolation of the country from other countries, were eventually the powerful means to nullify the high and patriotic projects of this company, causing its downfall, not, however, without leaving the seed of notable agricultural experiments, which later bore valuable fruit.

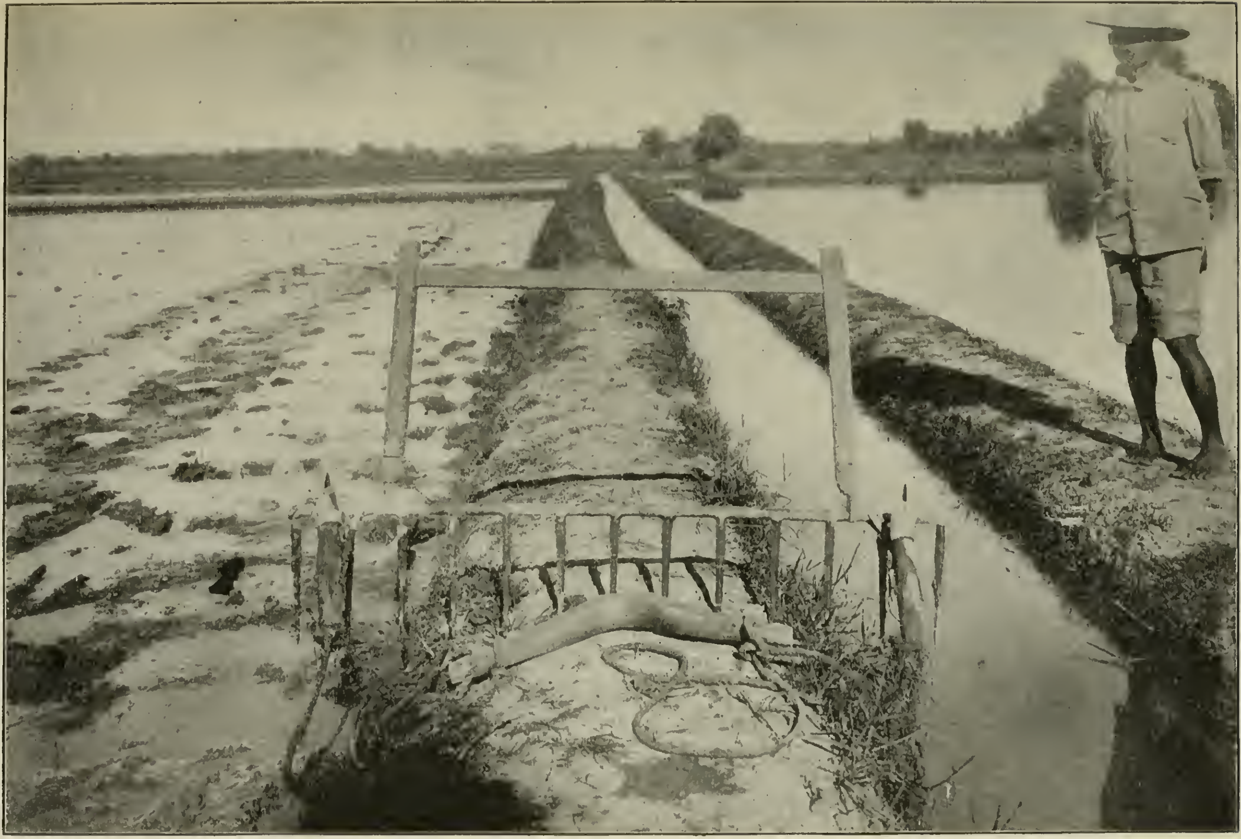
STATISTICAL FACTS.

A few statistical facts will aid in the comprehension of the slight importance of Philippine agriculture in the first years of the present century. In the beginning of this century, the exterior commerce—exportation—of the archipelago amounted only to some 4,795,000 pesos, of which 2,800,000 was the export of coined silver, sent for the purchase of silk and cotton goods and other products in China and Hindostan. One million seven hundred and forty thousand pesos more were sent to America, leaving only some 500,000 pesos to represent the export of Philippine products, properly so called, such as rice, ebony, anneal, sugar, cotton, shell, birds' nests, horns, etc. So that it may be said that at the beginning of the century the total exportation of agricultural products of the Philippines scarcely amounted to 400,000 pesos annually.

PRESENT STATE OF AGRICULTURE IN THE ISLANDS.

In spite of the conditions which we have just noted, and due to the popularization of scientific theories and the stimulus which generally has been lavished upon agricultural industry, and the admirable devel-

PLATE II.



A NATIVE HARROW.

opment which every class of industry has received in other countries, there is beginning to be reflected the beneficent influence in the Philippine territory, and the stimulus produces excellent results. Science likewise lends its aid in agricultural undertakings, bringing practical ideas to the mind of the cultivator and arousing him from his old routine.

MODEL AGRICULTURAL BUILDINGS AND STATIONS.

In addition to the meteorlogical observatory of Manila, whose services to navigation, commerce, and agriculture are well known to all, various royal degrees have been passed relative to the development of agriculture in the Philippines. We here note the most important.

By royal decree of the 8th of July, in the year 1884, it was decreed that in the future the agricultural department should be independent of the inspection general of state lands and should remain in charge of an agricultural commission, whose organization, object, functions, and duties were determined in regulations approved by the sovereign. By these regulations there were intrusted to the commission the following duties: First, study of agriculture, animal production, and the means leading to their improvement; second, theoretical and practical teaching of agriculture and animal culture and its derivatives; third, preparation of statistical and descriptive documents with regard to said productions; fourth, building of edifices devoted to agricultural teaching; fifth, editing of monographs with reference to agriculture in the archipelago and with reference to industries created; sixth, zoological studies; seventh, the making of agricultural collections, properly classified, to be sent to the minister of ultramar, and local museums to be created.

By royal decree of the 26th of November, 1887, there was ordered the creation in Manila of a school of agriculture whose object was the theoretical and practical education of skilled farmers, the education of overseers, and the promotion of agricultural development in the Philippines by means of observation, experiment, and investigation. In virtue of these royal acts the School of Agriculture in Manila was opened on the 2d of July, 1889. There are, in addition, two courses in agriculture given; one in the University of Manila, and another in the Ateneo Municipal. There exist two model farms in the provinces of Pampanga and Visaya, and five agricultural stations in the islands, which are at the same time schools for overseers.

The technical work intrusted to the agricultural stations mentioned is the following: First, the determination and study of the physical properties of the tillable soils of the region; second, mechanical analysis of the same; third, physical-chemical analysis of the same; fourth, qualitative analysis of the same; fifth, analyses and experiments by the scholars, and their employment in actual practice; sixth, study of systems of irrigation, quantity and quality of water, epochs and times of irrigation best adapted to cultivation; seventh, analysis and study of seeds, methods of sowing and grafting; eighth, study and analysis of secondary products of agricultural products and their uses; ninth, experiments with classes of labor, and with machines and instruments best adapted to cultivation; tenth, experiments with new kinds of products, and studies of their adaptability and cultivation; eleventh, study of the climate and its action upon products, of the natural fertility of the soil, the assimilation of atmospheric and other elements, and the manner of changing them; twelfth, study of the expense and products of actual cultivation and of reforms in the economy of production; thirteenth, studies with reference to herds and their races, qualities, feeding, care, and the acclimatization of new species and breeds; fourteenth, study of agricultural industry, industrial products, machinery, and reforms in industrial methods; fifteenth, study of the diseases or pests affecting crops and animals and the means of combating them and conserving products; sixteenth, solution of all other problems of technical or economical character which affect, or may affect, the agriculture of the region.

The chief of this service, the professors of the school, and the directors of the farms and farming stations are required to be agricultural engineers, with skilled, graduated farmers for assistants.

In the year 1887 a beginning was made of this work on the model farm of the Visayan, established in the town of La Carlota (situated in the island and province of Negros), longitude 123° east of Greenwich, latitude $10\frac{2}{6}$° north; height above the sea, 125 meters. It was established near the principal centers of cultivation of the archipelago. Its results have been recorded in a special publication.

The model farm of Luzon was established in the town of San Pedro de Magalang. It was situated in the province of Pampanga, longitude $120\frac{5}{6}$° east of Greenwich and latitude $15\frac{1}{6}$° north; height above the sea, 33 meters. On this farm there has been organized since 1888 a fold for the raising of horses of Arab breed for crossing with the horses of the island.

The five agricultural stations heretofore mentioned are as follows: First, that of Albay, in the province of the same name. It is situated in the southeast of Luzon $123\frac{4}{6}$° east of Greenwich, 13° 09′ north latitude; height above the sea, $10\frac{1}{2}$ meters. Second, that of Isabela Luzon, in the province of the same name, in the north of Luzon, $127\frac{5}{6}$° east of Greenwich, 17° 36′ north latitude; height, 42 meters above the sea. Third, that of Iloilo, in the district of the same name, in the island of Panay, $122\frac{3}{6}$° east of Greenwich, 10° 41′ north latitude; height, 8 meters above the sea. Fourth, that of Ilocos Sur, in the province of the same name, in the north of Luzon, $120\frac{1}{6}$° east of Greenwich, $17\frac{3}{6}$° north latitude; height, 15 meters above the sea. Fifth, that of Cebu, in the island of the same name, $123\frac{3}{6}$° east of Greenwich, $10\frac{2}{6}$° north latitude; height, 25 meters above the sea.

By decree of the general government of the islands, on the 22d of July, 1892, there was ordered the publication of a periodical, entitled Official Agricultural Bulletin of the Philippines, in which there should be published all the data relative to the work accomplished in the agricultural establishments mentioned; and by another decree, by the same authority, on the 3d of November, 1893, it was ordered that this periodical should begin to be published from the 1st of January, 1894. It began publication from the 1st of January, 1894, the chief of the agricultural service of the Philippines being director thereof, and the engineers and their assistants being the editors.

AGRICULTURE AND ANIMAL CULTURE.

Certain animals are intimately allied with agricultural production. They are so allied because without them agriculture could not easily progress, and because a certain number of the inhabitants must give

PLATE III.

A HERD OF CATTLE (SANTA ISABEL).

them attention, and because they produce without much cost various articles for the laborer, and, finally, because there are plants and products distinctly and only for their maintenance. Accordingly, after having set forth the principal vegetable products of the archipelago, we will speak briefly of herds and other domestic animals connected with agriculture.

PRINCIPAL VEGETABLE PRODUCTS OF THE ARCHIPELAGO.

In order to appreciate the actual agricultural condition of a country or region with respect to its products, it is sufficient to consider the most important. Although in the treatise on phytography it is set forth what are the principal crops of greater cultivation in the islands, nevertheless we will briefly enumerate them here, with some remarks.

Rice is the bread and principal sustenance of the natives. The land responds with wonderful fertility to the labor which the native puts upon it, rendering in good years from ninety to one hundred times the amount of rice sown. There exist more than 120 varieties of this grain, distinguished by color, size, taste, and adaptability. The ordinary price of rice, with its hull, called palay, at its place of production and in normal times, ranges from 6 to 7 reales fuertes per cavan (16 liters). The price of rice cleaned or hulled ranges from 15 to 16 reales per cavan.

The annual production of palay in the Philippines is some 17,000,000 cavans, but even this, united with maize, mangoes, and other food plants, does not suffice for the internal consumption, it being necessary to import from Saygon annually more than 1,000,000 cavans, of the value of 2,500,000 pesos on the average.

In certain Philippine provinces corn takes the place of rice as the staple article of food. Such is the case in Cagayan and Isabela de Luzon, where the cultivation of this product is alternated with that of tobacco.

Abaca (*manila hemp plant*).—Hemp occupies the chief place among fibrous and textile plants. Its enormous production has been limited to certain regions of the Philippine archipelago, as all the attempts made to introduce its cultivation and utilization in Borneo, Sumatra, and other points have failed. It constitutes one-third of the Philippine exports, it having been remarked, according to statistics published in 1894, that from the year 1818 to the year 1894 the production and exportation of raw hemp has increased from the insignificant quantity of 13,883 kilograms exported in said year 1818, to that of 93,741,824 exported in 1893 and valued at 12,558,548, according to official custom-house statistics.

Cotton.—Some time ago cotton attained some importance in the Philippines, because it was the principal material of the domestic weaving industry now reduced to very limited proportions, on account of the competition of English and Spanish cotton cloths, which are imported to the amount of 5,000,000 pesos, and of the tax on looms.

"We have not the slightest doubt," says Dr. San Martin, who has written a valuable little book on the cultivation of cotton in the Philippines, "that with a good choice of lands, with the adoption of seed the best adapted to the quantity and quality of the cotton harvested, and principally with the use of American cotton-working machines, either worked by hand or by any kind of motor, and without omitting anything essential, the greatest success would crown the work undertaken by cotton raisers. The sale of the product on favorable terms would be sure in Manila itself, where the certainty of having good cotton in abundance would probably lead to the immediate establishment of spinning factories and possibly of weaving factories also. Now that sugar is in a miserable state at present and has a future precarious and sad enough, it would be well for agriculturists and merchants to think of the great advisability of establishing cotton plantations. * * * An annual importation of more than $800,000 in cotton threads and of $7,000,000 to $8,000,000 in cotton goods we believe offers a broad field for competition to a Philippine agricultural and manufactured product of this most valuable textile material."

Sugar.—For a long period this was the chief article of export and one of the principal Philippine products. Afterwards the demand for and production of hemp grew in importance until it was placed at the head of our exportations, while, with rare turns of rising, the demand for Philippine sugar diminished. In the period from 1889 to 1893 the average sugar exportation amounted to about 11,500,000 pesos.

Three enemies as cruel as persistent mainly conspire to kill the exportation of Philippine sugar, and they are: Beet-root sugar; high freights, and the bad curing of sugar.

The very impure Philippine sugars contain great quantities of dregs and of vegetable acids already in a state of fermentation; which occasions a great loss of crystallizable saccharine substances in the refineries.

Tobacco.—Philippine tobacco represents now substantial wealth and a flattering future, because the tobacco business rests upon a solid basis, which is the excellence of the leaf, only excelled in the whole world by the justly celebrated Havana tobacco. For the present, limiting ourselves to the prepared leaf, or leaf tobacco, we shall say that from 552,000 pesos' worth exported in 1884, the exportation during the past five years has risen to about 2,000,000 pesos, without counting the value of manufactured tobacco, which is considerable.

These figures and this gradual increase observed in the exportation of our tobacco in the midst of the general crisis through which almost all the producing countries have been passing, overwhelmed with stocks larger than the demands of universal consumption, offer a legitimate and very pleasing outlook for the Philippines, because they clearly demonstrate that the only reason for this increasing demand for our tobacco is its marked superiority.

Indigo.—For many years Philippine indigo, especially that of Laguna and of Ilocos, was the worthy rival of that from Guatemala, which is considered the best in the world. But on the one hand the deceptions practiced blindly and avariciously by the Chinese traders, in whose hands this valuable trade had been, and which was discredited in consequence, and on the other hand the application to dyeing of aniline dyes extracted from coal tar, very cheap and with magnificent colors, although not very permanent, were potent reasons for diminishing to a great extent the demand for Philippine indigo.

In 1893 107,000 kilograms of solid indigo, valued at 85,000 pesos, were exported, and of liquid indigo 276,000 kilograms, valued at 13,500 pesos.

Cocoa.—Cocoa is a delicate plant, and although it is found in small quantities in several provinces of Luzon and Visayas, where it prospers best is in southern Mindanao and in the district of Davao, where it is produced in greater abundance and of better quality. The production is limited and is estimated to be some 2,000 piculs, which are consumed in the archipelago. The first cocoa plants in the archipelago are due to Father Juan de Ávila, of the Society of Jesus, for he used his influence with the Governor Don Diego de Salcedo to get from New Spain some living plants of cocoa, which he planted and cultivated with the greatest care in Ilog, capital of the island of Negros, where he then lived. (P. Delgado, S. J.)

Coffee.—Coffee was until a short time ago a very widely distributed product, which was found in the provinces of Laguna, Tayabas, Cavite, and especially in Batangas, which was the chief center of its production. Philippine coffee may be compared to that of Java and Martinique, but there are some localities where, according to experts, it is produced equal to that of Mocha. The statistics of the years 1887 and 1888 give a production of coffee in all the islands of 115,000 piculs, some 100,000, valued at 2,000,000 pesos, being exported, half of this exportation going to Spain and the rest to China, British India, and Japan.

In order that Philippine coffee may compete in the markets of the world with similar American products it only lacks perfection in shelling and polishing, which deficiencies can be easily remedied by apparatus suitable for correcting those defects.

For some time past the production of coffee has been diminishing to such a degree that during the year 1893 only 374 piculs of this valuable article were exported. The cause of this decadence is the destruction caused in the plants by an insect of the genus Xylotrechus, and by a fungus of the genus Peromospera.

Cocoa Palm.—This is a tree of inestimable value, because everything can be used, as we have said, in the proper place. It abounds in all the archipelago, and its fruit, the cocoanut, is exported to France, Spain, England, and China to the value of $675,432; and the oil only to China to the value of $15,445. It is generally exported in the form of copra.

STOCK RAISING.

In view of the vast plains which could be used for grazing, the herding industry leaves much to be desired in the archipelago.

Horses.—Most of the horses in the Philippines came from Mexico, Spain, and China. They are small and have hard hoofs, as mentioned in the zoography. The Indian does not take the care of them that such noble animals deserve; they make them work before they are full grown and overwork them in their races. The provinces which have the best horses are Batangas and Pangasinàn. They are plentiful, but more delicate, although better adapted to racing, in Ambos, Camarines, Albay, and Sorsogòn. Those of Ilocos are small, but strong. In Visayas the Mindoro horses are renowned, and they abound in Negros, Cebu, Iloilo, and Leyte. The horses of Mindanao and Jolò are very good and of good height, but rather wild; they are quite abundant in the districts of Misamis and Cotabatto.

Buffaloes.—These cattle are represented by the carabao or buffalo (*Bubalus buffelus* L.) of the bovine family. It is the most remarkable quadruped which the Spaniards found in the Philippines. There are few animals so ugly, but few more useful for agricultural purposes, especially in the Philippines, where it could not be replaced. It is black, or dark brown, its coat of hair being very streaked, its horns large, curved, wide, and rough; the head small in comparison to the large body. It has great strength in drawing heavy burdens, but its gait is slow and its movements sluggish. On account of its great resistance to the heat of the climate and the great ease with which it fords large rivers, and works the marshy lands, into which all parts of the archipelago are converted during the rainy season, it is invaluable. The buffalo is also indispensable in the Philippines, because without it it would be impossible to travel through many regions, especially in the rainy season. It begins to work when 4 or 5 years old, and lives until 30, and its horns and hide are very useful. The buffalo is uniparous, has an ugly appearance, a good scent, and excellent hearing. It eats much and needs to drink often. It is supposed that there are a million and a half head of these cattle.

This animal is the most abundant and the best developed in the country; it is almost the only animal used in agricultural work, and as a beast of burden. The provinces where most are bred are Pangasinan, Pampanga, Albay, Laguna, Morong, and Zambales, in Luzon. In Cebu, Iloilo and Negros, in Visayas, and in Mindanao, in the districts of Misamis and Cotabatto.

The wild mountain buffalo in a savage state is to be feared. Meeting with it in the forests is really dangerous for men.

Neat cattle.—This species does not belong to the Philippines, but came from Mexico and China, and is not as useful as in other countries. Ordinarily it is only raised for beef. In some provinces they are beginning to use oxen for field work and as draft animals.

The best neat cattle and the most abundant are found in the province of Batangas, where they substitute the buffalo in a great measure for field work. They are also plentiful in Mindoro, Masbate, and Ticao, from which islands the dealers of Manila are supplied. There are also good cattle ranches in the island of Tabiliran, northern Luzon, in Calamianes and Benguet. In Visayas neat cattle abound in Negros, Cebu, and Iloilo, and in Mindanao, in the districts of Misamis and Cotabatto.

Sheep.—These animals do not prosper in this archipelago, and there are very few and miserable specimens of this most important kind of cattle.

Goats.—These are bred to a cetain extent, especially in the mountains. The provinces where there are most are Batangas, in Luzon, in Visayas, Cebu, Iloilo, and Leyte, and in Mindanao, in the district of Misamis.

Pigs.—These are more abundant and of more utility in the Philippines than the two previous classes. The Philippine swine are of Chinese breed. Their principal use is that of the breed, that is to say, for making lard. In small towns, and even on the outskirts of large ones, almost all the inhabitants raise pigs. The provinces where there are most are in Luzón, Batangas, and Pampanga, in Visayas, Cebu, Iloilo, and Samar, and in Mindanao, Misamis, Cotabatto, and Zamboanga.

Domestic fowl.—Chickens abound throughout the archipelago, but they are only raised on a small scale, and there are no special breeds which merit particular mention. Turkeys are also raised, but in the same way as chickens.

Ducks.—The ducks raised in the town of Pateros (near Manila), where all the inhabitants are engaged in this industry, deserve special mention. The breeding places are located on the banks of the Pasig River, in the form of yards fenced with bamboo cane about 1 yard higher than the level of the water, where the adult ducks pass the day. Near this there is another inclosure where there is less water, where they keep the medium sized ducks or those beginning to have feathers. Behind these two inclosures there is another smaller one, with a floor of woven cane or sanali, where the little or newly-hatched ducks are kept.

The food of the little ducks consists of boiled rice, or morisqueta, and small crabs. The larger ones are given palay, or rice in the husk, and a small snail, called by the natives susó, which comes from Laguna de Bay.

In the duck houses, which are not far distant from the duck yards, there is the same separation. At sunset all the ducks retire in an orderly manner to their respective departments, to return to the yards at daybreak on the following day in the same order. It is hardly daylight when the bantay, or keeper, opens the doors. In the duck house there is a floor of rice husks 10 centimeters thick and a light burning all night. After the ducks are let out in the morning and fed their usual ration, the keeper gathers the eggs laid by the ducks into little heaps of from five to ten. Those collected are taken to the general storehouse until the number necessary for one setting is collected.

Near the house of the proprietor, not far from the duck houses and duck yards, there is a house or room of bamboo and palm leaves, carefully built, and with as few apertures as possible—sometimes only that of the door of entrance. The interior walls are of bamboo or woven cane, and the floor is a thick layer of rice husks or ipa. Around the walls at the distance of a meter a sort of barrier is raised with woven cane (matting), and between this and the wall some baskets, called toangs, are placed to receive the eggs for hatching. The space between the wall and the barrier is filled with rice husks for the purpose of isolating the interior temperature of the baskets from that of the outside room.

At the entrance door of the room there is an iron boiler, wherein the rice husks, contained until then in bags of hemp cloth, are heated. When the husks are heated they are replaced in the same bags, near the baskets or toangs, where are already prepared 1,000 eggs in the same number of bags as those containing husks, usually eight. A bag containing husks is then placed at the bottom of the basket without emptying it, and above it one of eggs, and so on in layers. The temperature is kept 36° to 37° C., and in order to do it the operation of heating the husks and returning them to the baskets is repeated every day, taking care to place in the bottom layers those eggs which were the day before in the top layers. After twenty-one days the eggs are taken out and put on tables in the center of the room. On each table 1,000 eggs are placed, arranged so that they touch each other, and covered with blue cotton cloths to protect them from the light and somewhat from the temperature of the room. The eggs have a temperature of 32° C., approximately, and are kept at this temperature for eight days, when the little ducks begin to hatch out everywhere. At this time the keeper, who during incubation sleeps alongside of the same table, gathers up the little ducks one by one and puts them in a broad basket of reeds or bilao, with straw, under the table, where they all perspire and dry off for one or two days. Thence they are taken to the small duck yard already mentioned. When they are grown the male ducks are taken to market, the females being kept for breeding purposes.

MEANS FOR THE SUCCESSFUL DEVELOPMENT OF AGRICULTURE.

NECESSARY KNOWLEDGE.

Agricultural production is a vast problem, susceptible to an infinite variety of combinations and solutions, and in which a considerable number of elements, not only differing from each other, but variable, by reason of a multitude of accidental and unforeseen circumstances, and which it is frequently difficult to appreciate and discern, enter, so that what is true for one locality is not true for another, what is good in this district and beneficial is prejudicial in another, what can be used with profit on one farm may possibly be ruinous on another neighboring one, what has turned out well one year may be a failure in the following, and, finally, what may give a profit at one time may by reason of this or that circumstance soon fail to give it.

In this state of things it is readily seen that it is impossible to take into account the infinitely changeable influences which in greater or less degree are involved in the phenomenon of agricultural production, both from the point of view of the laws of nature as well as from the standpoint of the mechanical and economical means to which it is subject at the will of man.

In order to properly work a farm to get out of it the crops it should produce, it is not enough to have a theoretical and practical knowledge of agriculture, it is necessary to add to it exact notions of the following points:

(1) The best system of cultivation to follow, according to the nature of the land, its location, and all the circumstances which may influence the growth of the products.

(2) The preference which should be given to certain crops which yield the most profit and which are best adapted to the nature of the land cultivated.

(3) The most economical methods of obtaining the greatest possible amount of crops.

(4) Finally, the best means of utilizing these products and getting from them the greatest net profit.

PROTECTION ON THE PART OF THE GOVERNMENT.

One of the duties most proper to a government and of great responsibility is the encouragement and protection it owes to agriculture, because from perfecting the same and the development of the arts necessary for the utilization of its products the welfare of a people is derived, a well-being which it is especially incumbent upon a government to promote. The Filipinos, with the elements contained in their soil, will be able when the time comes to devote themselves with much profit to all kinds of industries; but in order that these industries may have rational conditions of life and prosperity the first thing to do is to give the Philippines, by means of a good system of cultivation, agricultural industries.

By system of cultivation is understood the diverse processes which are employed for working arable land, harmonizing the forces of nature which work all the time and by themselves and those which, depending on man, he may use and direct as he pleases. According to this there must be many systems of cultivation, because there are many different ways of obtaining products from the soil. Left to itself, and therefore limited to the forces of nature, the earth becomes covered with wild vegetation destined, according to the quality and situation of the lands, to form meadows or forests, which in a certain way may be made to alternate with products obtained by the work of cultivation. The choice of a system of cultivation is one of the things which should most attract the attention of the agriculturist. To determine with probabilities of certainty what may be the system of cultivation best suited to a farm there is necessary (1) exact knowledge of the nature of the land; (2) of the influence its location may have on its vegetable products; (3) of the means at one's disposal.

MEANS OF COMMUNICATION.

Having perfected the methods of cultivation and the development of agricultural production, the Government should utilize the proceeds of taxation by inaugurating the construction of good cart roads, establishing a good system of neighborhood roads, and undertaking canal works, which fertilize the lands, give an outlet for its products, life to internal traffic, and food to external traffic. In this way abundance, cheapening the products of the soil, will increase the wealth of the country without detriment to the laboring classes. Ease of communication and the proximity of places where the cultivator can dispose of his goods are a real and positive advantage which can not fail to enter into consideration and to powerfully influence the value of a piece of arable land. It is never well to lose sight of the capital represented by herds and animals used for transporting farm products to market, whose cost should be deducted from the proceeds of the sale of these same products. In this connection, those agriculturists do not calculate well who are accustomed to transport the products of their farms for a long distance in order to get a profit which is apparently greater but in reality much less than the expenses occasioned by the journey.

COMBATING FALSE NOTIONS.

If agriculture in the Philippines is to reach the state of prosperity of which it is susceptible, it is necessary for the Government to duly foster the diffusion of agricultural knowledge and cause this empiricism, which nullifies with its tenacious opposition to every sort of improvement the natural fertility of the Philippine soil, to disappear. Wherever the sight rests in the Philippines the fatal results of this empiricism, the inevitable consequence of indifference, are seen. Cultivation in a miserable state, on account of the lack of well-directed labor; weak and degenerate stock. These are the two industrial elements which separately, as a rule, dispute the development of this territory. Outside of a more or less circumscript radius around the great centers of population, in which there is more or less local consumption, but always of some importance, it is a chimera to expect large profits for the cultivator and improvements in the agricultural art, without machines, which simplify and cheapen labor; without live stock, which at the same time that they supply the motive power economically and plentifully for said machines, also furnish the manure so necessary to all agricultural development.

INTRODUCTION AND PROPAGATION OF NEW PLANTS.

The introduction of new plants and their propagation throughout the provinces is advisable, such as that of the mulberry tree, which formerly gave such good results in the silk industry. It would be advisable likewise to cultivate the nettle for the valuable fibers and sorghum for alcohol and sugar. Many oleaginous and dyeing plants and even sugar cane would give larger and better crops with better means and careful processes in the different operations of the respective industries. The use of fertilizers, almost unknown to the natives, should be introduced. The many places that are not used for anything should be made use of for herds of horses and cattle.

SPECIAL REMARKS.

One of the first measures which should be taken is the increase of the number of model farms and agronomic stations, so that the agricultural necessities of all the archipelago may be studied in a perfect manner, because the climatologic and telluric conditions are as different as the islands are different which compose this extensive archipelago.

The island of Mindanao, where all the most important products of the archipelago can be easily cultivated, and where on account of the lack of population they can not be taken advantage of, demands special attention on the part of the Government. To this end, it would be advisable to plant in that region, besides a model farm with its corresponding agronomic stations, some private companies or societies of colonization and development, managed by persons of undoubted honesty and of competent knowledge for such business, for the ground is worth as much as the man.

PAPER NO. XII.

PUBLIC WORKS AND EDIFICES.

PUBLIC WORKS AND EDIFICES.

PUBLIC EDIFICES AND OTHER WORKS.

IN GENERAL.

The building materials at the disposal of the Filipinos, the climatological conditions of the country, the frequency in it of earthquakes, and the greater or less degree of culture in the different districts and localities, have chiefly determined the structure and aspect of the edifices and even of works in general in the Philippine Archipelago, so different from those of other parts of the world, and which seem so novel to the European who arrives here for the first time.

VARIOUS CLASSES OF EDIFICES ACCORDING TO BUILDING MATERIALS.

Beginning with works more properly called edifices, undoubtedly the great majority of them are built of light materials, there being understood as such, bamboo, nipa palm leaves, grass, etc., excepting wood, which in the form of timbers or beams may constitute the frame, which is also made of bamboo in a great many dwellings. A goodly number of edifices, especially in large, well laid out towns, besides having the frame made of good timbers and beams, are wholly built of wood, the nipa palm leaves being only used for the roof or covering. There are included in this class of buildings very good, substantial, and beautiful houses, churches, manufacturing, and mercantile establishments, railroad stations, barracks, and even small military forts, constructed according to architectural rules and elegance, in which, besides, the nipa roof is frequently substituted by galvanized iron. Also from ancient times there have been in use in the Philippines, and are still being built, edifices of irregular stones and mortar—at least their walls, to a greater or lesser height; others of strong walls resting on a good foundation of hewn stone; and even some whose exterior walls are wholly faced with hewn stones on one or more façades. The old buildings usually have tile roofs; that is, made of earthen tiles, now generally substituted by iron plates. Finally, this same metal cast in pieces or wrought in bars has been utilized in the archipelago as an important building material, and not many years ago there was a church built whose frame, walls, pillars, and roof were all of iron.

OBJECTIONS TO ALL BUILDING MATERIALS.

The nipa palm is often like tinder. A spark will often set it afire, and the heavier timbers of a house only serve to feed the fire. The houses built of irregular stones and mortar are considered the most dangerous when an earthquake occurs. Even the strongest is so in case of earthquakes. Tiles are in such cases the worst roof. Iron becomes very hot, and the plates of the same, if they are not well fastened, may be lifted and torn away by the typhoons. There is no kind of construction without objections which the constructor must try to overcome, and advantages which he will study how to avail himself of, with due attention to what is necessary and desirable for the special object of the work, and of the means and resources at his disposal. Mr. Cerero,[1] in a conscientious work which he published, gives very definite instructions about constructing edifices so that they may oppose both to earthquakes and winds all the resistance possible. To prevent the effects of the former, buildings in the Philippines do not usually have more than one story, or at most two, above the foundations.

PUBLIC EDIFICES: WHERE AND WHAT.

Overlooking the little which in the way of buildings may attract attention in sparsely populated lands, in ranches, villages, and even in the majority of small places, it is our duty to say that all the civil towns have these public edifices: The church, the convent, the court, and the two schools for boys and girls frequently joined together and so placed that they surround a square. To these must be added the cemetery, more or less well inclosed and suitable. In the capitals of provinces or districts it is also customary to have a government house or royal house, as it is called. In certain capitals, besides, and perhaps in other towns which are not, there are located other centers: Official, ecclesiastical, civil, army, or navy, or dependencies of the same; all of which occupy their respective buildings, constructed or adapted to their purpose. This may likewise be said of the establishments erected by the companies or mercantile or industrial societies, by religious corporations, or by private or public charity, or supported by pious foundations in favor of beneficence or public instruction, scattered throughout the archipelago. The buildings which all these centers and dependencies occupy are not always owned by them, but frequently rented from private parties. The ecclesiastical establishments usually own their buildings, as well as the companies and manufacturing and commercial enterprises.

OMISSION OF DESCRIPTION.

It would be ridiculous, because impossible, to try to give a description here of all the buildings of the archipelago to which we have referred, and even to do so of the principal ones of the various kinds mentioned would be tiresome. Moreover, a brief sketch or enumeration, besides being probably incomplete, would be of no use. A vast country like this, where there are established all the organizations of the State and of the church, and many institutions of various characters which the Catholic civilization of Spain and public and private enterprises have been accumulating for a period of almost four centuries, it is understood, must have a considerable number of houses for the dwellings of its governing classes, central and subordinate offices of administration, audience chambers and courts, cathedrals, episcopal palaces, seminaries and convents of religious communities, with their

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[1] Study of the Resistance and Stability of Buildings Subjected to Hurricanes and Earthquakes, by the Brigadier-General, Commander-General, Inspector of Engineers of the Philippine Archipelago, Don Rafael Cerero, Madrid, 1890.

Plate I.

BRIDGE OF SPAIN (MANILA).

Carabaos bathing.

churches, military establishments, army and navy posts, barracks, hospitals, and military infirmaries, storehouses and factories, public hospitals, hospices and benevolent institutions, colleges, asylums with monasteries and nunneries, scientific establishments, banking houses and other economical, trading, and manufacturing institutions, and even of amusement and diversion, with which the outer life of people is manifested. In the treatise on geography mention is made of the greater part of these edifices in describing the cities and towns.

REMARKS.

The church, as well as the state and various enterprises, chiefly benevolent, have built in the Philippines in the course of the Spanish dominion very good, substantial, and handsome edifices. Not a few, in spite of their strength, have been destroyed by the earthquakes, especially by that of 1863. Within the walls of Manila there were destroyed, among others, the magnificent palace of the captain-general, with an elegant façade of the Doric order; the cathedral, all of cut stone of the Ionic order in part, which cost 500,000 pesos, and which had been preceded by three others, was included in the ruins; also the consistorial houses, of modern construction; the beautiful church of the Society of Jesus, which occupied, with its adjoining house, a space of 28,900 meters; the custom-house, the tribunal of accounts, the hospital of San Juan de Dios, and others. The church of San Augustin lost one of its towers, and its vaulted roof was split open throughout its length.

In the rest of the archipelago the earthquakes overthrew other buildings, also, which appeared to be very solid. The effects of the earthquake of Pangasinan, in 1882, are still visible. Other buildings have been buried forever by volcanic eruptions. And another very different phenomenon is quite recent—the tornado of Samar and Leyte of 1897, which caused great ruin and damage to important buildings in those towns.

In Manila the greater part of the public buildings destroyed some time ago have been rebuilt or repaired. The church of San Domingo was rebuilt for the fifth time in 1868. The fifth cathedral also—the one now standing—was finished in 1880. The palace of the governor-general is in the beginning of its total reconstruction.

To-day the best edifices in Manila are, if we accept the opinion of Tariel de Andrade,[1] the convents. That of the Franciscans with their church occupies an extent of 25,000 square meters; that of the Augustinians 21,250; that of the Dominicans 12,750; that of the Recoletos 10,200. All of them are handsome and with views on four streets. The said author adds to the list of notable buildings the University of St. Thomas, the College of San Juan de Letran, the normal school for teachers, the ateneo municipal (school), the nunnery of Santa Catalina, the colegios de Santa Isabel and Santa Rosa, the municipal school for girls, the convent of Santa Clara, the school for native girls or called the convent "de la Compania," the custom-house, the tribunal of accounts, the artillery storehouse, various barracks, and the hospital of San Juan de Dios. To which we should add others of equal or more importance, such as the "intendencia" (commandant's residence or office), the offices of the civil government, the audience chamber, the palace of Santa Potenciana, the general commandancy of engineers, the barracks of Santa Lucia, the archiepiscopal palace, the old seminary, and others of later construction, as the new consistorial houses, the new seminary, and the new Spanish barracks. These are within the confines of the walled city, whose maximum area without doubt so many buildings of a public character occupy.

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[1] History of the Exposition of the Philippine Islands in Madrid in the year 1887, Vol. II, Chap. XI.

Neither are there lacking very notable buildings in the suburbs, as for example, the handsome churches of Tondo, Binondo, Santa Cruz, and Paco. The suburbs also contain the Hospicio de San Jose, the military hospital, the palace of Malacanang, the office of the captain of the port, and some handsome newer buildings, such as the barracks of Meisic, Arroceros, and Malate, and the "monte de piedad" (public pawnbroker institution) and savings bank. In the suburbs, likewise, new markets are building or proposed; and as the suburbs are the center of mercantile and manufacturing activity, there are not lacking establishments of various kinds, very extensive and well arranged, such as the Hotel of the Orient, the tobacco factories, La Insular and La Flor de la Isabela, and a great many and very sightly business houses. Finally, on account of greater space, air, and salubrity in the suburbs, there have been building for some years past private houses, in modern style, of fine appearance, and with comfortable interiors.

We shall omit all other details on the subject of public buildings, although we could mention not a few outside of Manila, if we should begin to review among others capitals as important as Cebu and Iloilo in Visayas, and Vigan and Nueva Caceres in Luzon itself.

SOME ESTIMATES.

We are going to permit ourselves to make estimates, although very briefly, regarding the properly artistic form of the buildings of which we have just spoken. We must at once frankly confess that in our opinion up to the present time there have hardly been any true architectural monuments which could be properly called artistic. We believe that the chief causes of this phenomenon have been these two: First, because the centuries of Spanish domination in the Philippines, almost the only influence which impressed its seal on the architecture of the country, were not, even in the metropolis, the centuries of splendor in art, but rather centuries when good taste was scarce; even in the Peninsula the monuments of beautiful architecture are anterior to the fifteenth century, or of relatively very modern date; that is to say, already belonging to the times of the present artistic renaissance. Second, we attribute it to the climatologic and telluric conditions of the country above referred to, which do not permit architects to give free rein to their genius and apply in Philippine construction certain orders of classic, or, more strictly, æsthetic architecture. So it happens that the most remarkable buildings of the Philippines are so, generally, on account of their great size and on account of the solidity of their construction, as we have before indicated.

We have in the Philippines large churches of great capacity and thick walls, such as many in Manila and outside of it, that of Taal being among the most remarkable; but we lack churches properly Byzantine or of good styles, pure or combined. We might say the same of other kinds of edifices. However, a few years ago something

Plate II.

BRIDGE OF PALO (LEYTE)—BUILT BY A FRANCISCAN PRIEST.

began to be done here—that is, the renaissance of good taste in the metropolis did not utterly fail to reach the colony. For which reason we do not think that it is impossible to harmonize in the Philippines the various local exigencies in the matter of building with some of the laws of æsthetic art and certain elements of good taste. In Manila, examples of good architectural style are the above-mentioned buildings, the monte de piedad (charitable pawnbroker shop), the ayuntamiento (town hall), and the new seminary; and even La Insular, the Oriental Hotel, and some other modern buildings are examples of good taste. In churches we have no better model, in our judgment, of good style than the cathedral, of good Romano-Byzantine taste, very severe and suitable, and the church of San Ignacio, of Greco-Roman style with Corinthian details, and very handsome.

FORTIFICATIONS.

Neither shall we say more of this kind of construction than some generalities and brief remarks in particular, referring for further information to the chorography.

There are fortifications in many places in the archipelago, generally located on high places, some as towers or stone defenses, destined in former times as a refuge and defense for the people who had built them against the surprises and attacks of the natives. Now they are hardly of any use.

In other places more important and strategical, and at later dates, there were fortifications planned according to the rules of military engineering then current, although still insufficient to withstand modern artillery. The walls of Manila, with the moats, drawbridges, forts and counterforts, and good batteries, made the capital some time ago a veritable stronghold. The arsenal of Cavite was as much so, but it still remained very well defended by its own fortifications and supported by the battery of Point Sangley and by the small fort of San Antonio. Jolo was also a strong place on account of the bulwarks around it, although the wall, with which a short time ago they were united, is weak. With pretty good batteries it could still be defended against the imperfect artillery used by the natives of that place. As an advance guard there are two forts near by and one at a distance toward the south, also of modern construction.

It does not appear that there are any other towns in the Philippines which may be called strong places, although there are some which do not have walls about them, but which have near them fortresses more or less good. The following have their respective fortresses: Iloilo, Cebu, Iligan (called there "Cotas"), Zamboanga (Fort Pilar, especially the old part erected by P. Melchor de Vera, which the recent severe earthquakes left unhurt, and furnished in a modern manner with handsome pavilions), and Isabela de Basilan (on an adjacent height, the plan of which fort received a premium in the Philadelphia Exposition, the work being already injured by said earthquakes). They are of hewn stone. The fort of the port of Santa Maria, although on a strategic height, that which defends the military post of Sindangan, and others occupied by other military posts in other points of Mindanao or of the archipelago, do not now deserve such honorable mention as military works.

Lately, also, and to facilitate the complete subjection of the natives of the south, there were erected on the Rio Grande de Cottabato, in the Bay of Illana, in Sabanilla and in the of Iligan at Marahnit, in Mindanao, a number of stone fortifications of sufficient strength for the purpose for which they were intended, namely, the defense of the positions of the Spanish military posts against the natives of Rio Grande Laguna de Lanao and ranchmen of the bay Illana. Besides the works which constitute the military encampment of Parang-parang, the fort of Reina Regente in the delta of the Pulangui is probably the best of all.

Finally, it is hardly necessary to mention the series of wooden block houses which were constructed on the exterior line of defense of Manila, and which were of service in the last war against the Philippine insurgents and during the siege which terminated with the occupation of the capital by the North American troops.

SEAPORT WORKS.

We shall mention particularly the following:

Port of Manila.—By royal decree of the 2d of January, 1880, there were established, with the exclusive object of executing and preserving the port works of Manila and for the time that might be necessary, the following taxes: Two per cent on the value of goods imported; 1 per cent on the value of goods exported; 20 centimes per ton of burden for ships navigating the high seas; and 10 more per ton of burden for coastwise vessels. There was also granted for the same object the duties on fisheries in the bay, the proceeds of the sale or hire of the lands recovered from the sea, and an additional $12,000 per annum assigned in the general budget. Finally, the commission of port works was created and salaries were assigned them. With these resources and under this direction the works of the new port of Manila were begun and carried on, until now they are far advanced, but still incomplete, and of which we shall not give details. The final result must be a truly magnificent fort. At times the work came to a standstill; and it is said that a great part of the funds collected were used in war expenses.

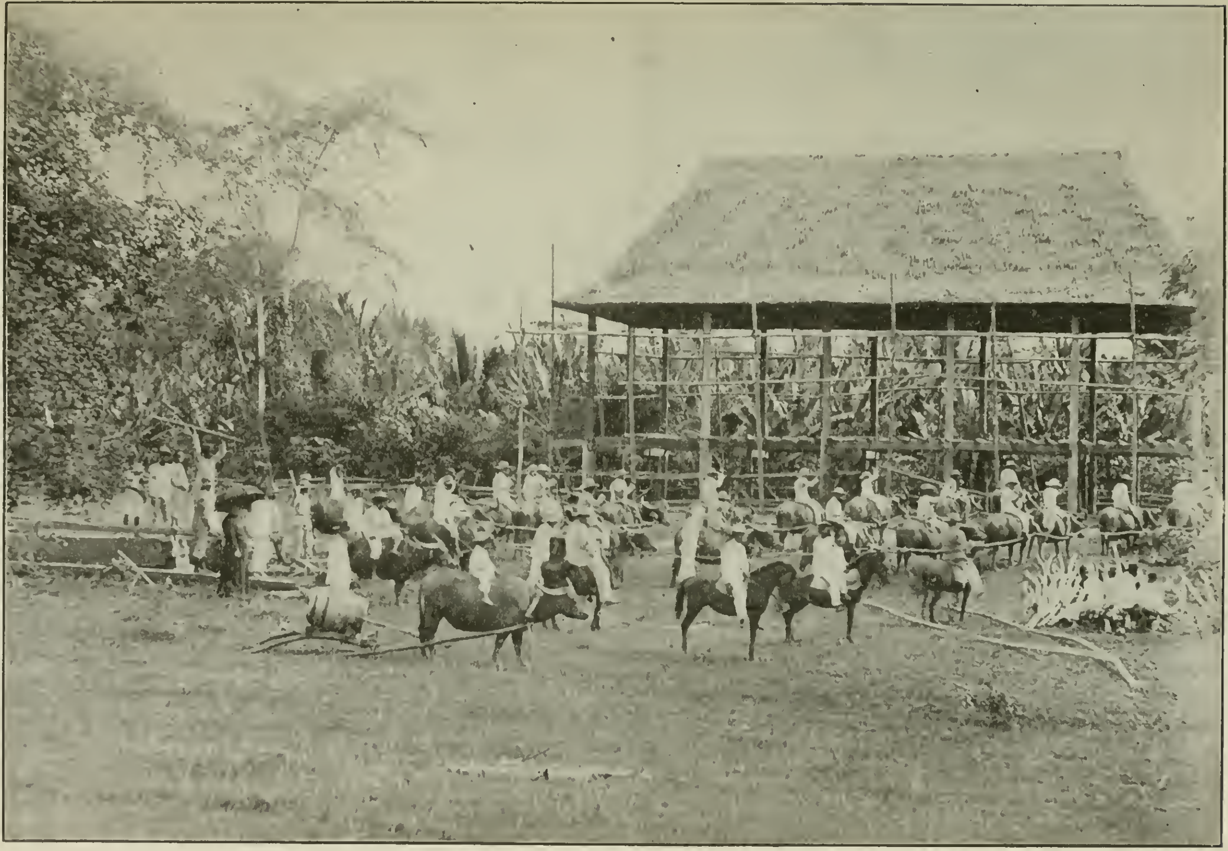
Dry dock of Canacao.—Although it appears that the commission of port works of Manila proposed to construct a dry dock, they did not succeed in realizing the project. After the year 1886 the government of Madrid granted to a stock company called the Manila Dry Dock Company permission to construct it, as indeed they did, in Canacao (Cavite). It is magnificent, and the steamers which navigate among the Philippine Islands are cleaned and repaired in it.

Army and navy works.—Besides the dock yards and magnificent arsenal which the commandancy general of the Philippine navy has in Cavite, the naval division of the south, located in Zamboanga, has a station very well appointed and furnished in La Isabela de Basilan and a small wharf in Polloc (Cottaboto).

Proposed port and arsenal of Subic.—This beautiful and, as they say, most useful project is in the beginning of its construction near the town of Olongapo (Bataan). There is much difference of opinion about it, and the Spanish Government proceeded very slowly and with limited funds in its execution.

Other maritime works of lesser importance.—There are, indeed, many in the ports of the archipelago, which, although they may be called natural ports, have the shores strengthened with wharves or pilings, more or less costly, and firm piers, which project some meters into the water to facilitate the loading and unloading of cargo.

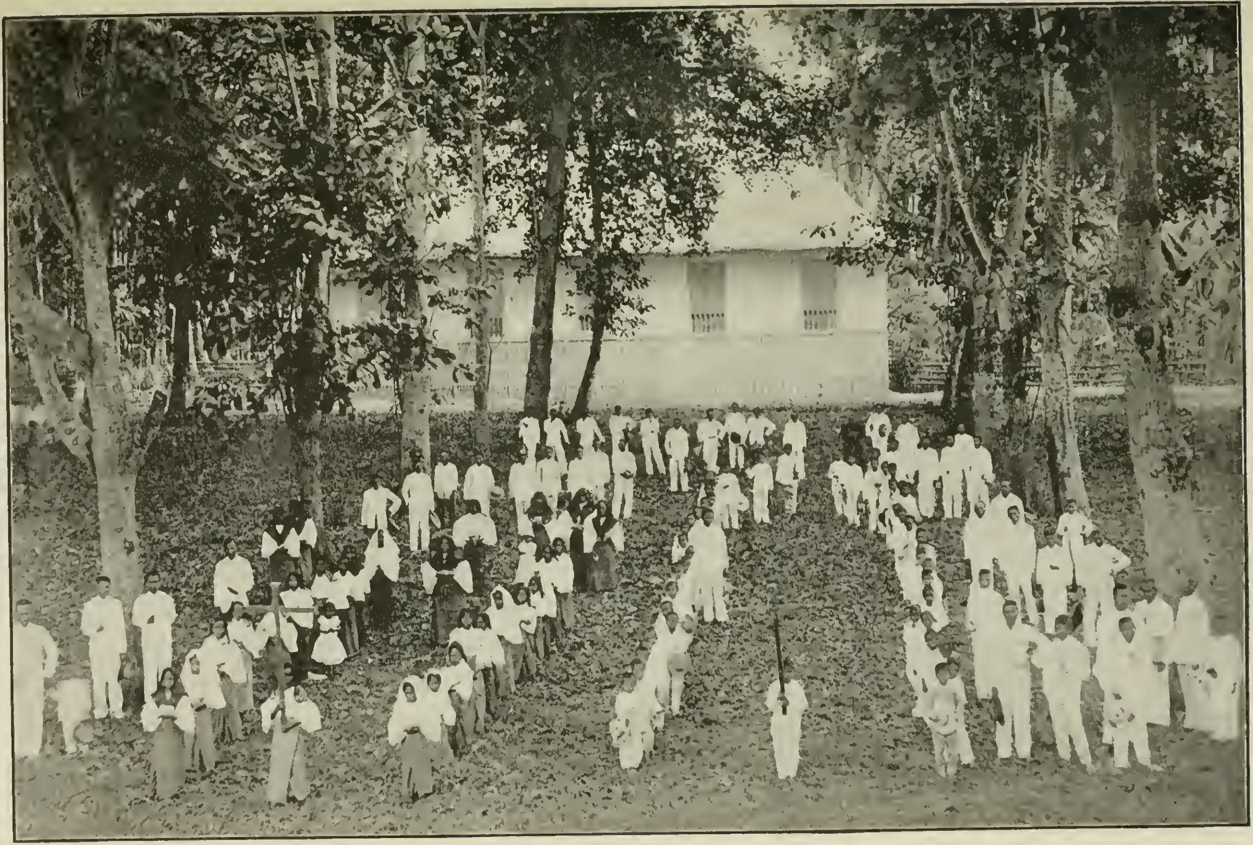
PLATE III.



HAULING A HUGE TIMBER FOR THE SCHOOL OF MERCEDES, IN COURSE OF CONSTRUCTION (ZAMBOANGA).

SCHOOL OF MERCEDES, IN COURSE OF CONSTRUCTION.

PLATE V.



BOYS AND GIRLS IN PROCESSION FROM SCHOOL (TETUAN, ZAMBOANGA).

We have already considered light-houses and buoys in speaking of maritime hydrography.

Canal and waterworks.—Very few works of this kind have been made in the Philippines and of very little importance, which, even taking into consideration the climatic conditions of the country, would doubtless be of the greatest utility if carefully executed in certain districts. For waterways the Filipino people take advantage almost entirely of the marshes of the rivers, which, fortunately, are many. Some ditches and small canals have been built by monks on their properties, and possibly some by municipalities or provinces, assisted by the state with a small credit; but all of them are works of relatively little importance and merely of local or very partial utility.

The same may be said of waterworks outside of Manila. Some towns have water brought by ordinary open ditches or closed conduits from sources not very distant; and we have heard of other projects of more importance, which, unfortunately, have not been realized. Only the following deserves special mention:

CARRIEDO'S DRINKING WATER.

Formerly and up to not very long ago the city of Manila did not have drinking water. The majority of the houses had cisterns to provide themselves with rain water. The illustrious Spanish patrician, Don Francisco Carriedo y Peredo, who died in the last century, left in his will a bequest to introduce this great improvement into the capital. The capital accumulated, according to Taviel de Andrade, at the beginning of the work amounted to $250,000. At 2 kilometers from the town of Mariquina, not very far from Manila, the water is taken from the river of the same name. It is conducted through large iron pipes to the reservoirs constructed in Santolan, whence it is conducted and distributed by pipes of different diameters, all of cast iron, to the city. The work was begun in 1878 and on being finished was inaugurated in 1882 under the direction of the engineer, Don Genaro Palacios. There are more than 390 fountains, which the public use gratis; there are 280 fire plugs. Some establishments have grants of water for their use by the disposition of the founder himself or by permission of the town council.

PAPER NO. XIII.

HEALTH, HYGIENE, POLICE, AND PUBLIC ORDER UNDER SPANISH SOVEREIGNTY.

HEALTH, HYGIENE, POLICE, AND PUBLIC ORDER UNDER SPANISH SOVEREIGNTY.

HEALTH AND HYGIENE.

GENERAL INSPECTION.

There is in Manila a board of general inspection of charities and health, which supervises from a civil standpoint all matters relating to these two branches in the archipelago. Therefore the corps of titular physicians, the maritime health boards, the bathing establishments and civil hospitals and pesthouses, the municipal board of charities, that of vaccinators, and the subdelegations of medicine and pharmacy are dependent upon it.

TITULAR PHYSICIANS AND HEALERS.

For the skillful attendance of the sick poor and the inspection of public hygiene in the towns of these islands the government has created and is still creating the office of physicians called "titular," sufficiently qualified, according to the number of inhabitants and importance of the provinces and localities. At the beginning of 1898 there were 42 in the island of Luzon, 18 in the islands of Visayas, and 6 in that of Mindanao. The titular physicians also exercise the function of court physicians.

Besides in rural towns of small population, distant from capitals, and therefore destitute of professional physicians, the authorized attendance on the sick is in charge of healers, that is, of persons without an academic degree in medicine, but with some knowledge of it and much practice, who take the place of a regular physician by appointment and payment of the government.

MARITIME HEALTH.

The care of maritime health in this archipelago is intrusted to the maritime health boards established in some ports of the same, namely, Manila, Iloilo, Cebu, and Zamboanga, which are composed of one director, first physician for visiting ships, second physician for visiting ships, a secretary, a substitute, an interpreter, and the necessary subordinates. They do not always have all this staff, and sometimes they also have it for the service of the boat of the board.

BATHS.

Because they are the most frequented and the best equipped for the public service, the following four baths belonging to the island of Luzon deserve special mention: Sibul, in the province of Bulacan, which include the waters of San Rafael, Santa Matilde, and San José; Aguas Santas and Galas, in the province of Laguna, and Tini, in the province of Albay, in which are found the waters of Jicabo and Naglabong. Of these four establishments, that of Aguas Santas had a beautiful building,[1] the property of the state, and at its head a director of the medical corps of baths, in whose charge is also the authorized direction of Galas; that of Tini has comfortable lodgings and skillful direction equal to that of Aguas Santas. Sibul had also a suitable building for the bathers;[1] that of Galas has not yet been built.

LAZARETTO.

To observe persons coming from suspected ports, there is a lazaretto in Mariveles, near the entrance of the Bay of Manila. It is in charge of a first medical director, a second physician, and an interpreter and secretary, with the number of subordinates the service requires.

MIDWIVES.

There are 22 titular midwives paid from the public treasury and distributed as follows: Twelve of the first class, of which there are 6 in the province of Manila and its environs, and 6 others for each one of the provinces of Albay, Batangas, Bulacan, Laguna, Pampanga, and Pangasinan; five of the second class for Ambos, Camarines, Cavite, Ilocos Norte, Ilocos Sur, and Zambales, and 5 of the third class for those of Bataan, Cagayan, Isabela de Luzon, Nueva Ecija, and Nueva Vizcaya. This service was inaugurated the 6th of May, 1887.

VACCINATORS.

After having worked hard to persuade the natives of the advantages of vaccine inoculation, as it was seen that neither reasons nor facts nor the great mortality of children produced the desired conviction, it was necessary for the government to appoint, as it did in 1849, vaccinators with a salary, and to order the obligatory presentation of children one day in the week before the chief of the province, and in towns before the curate, and to give statements and exact accounts of the performance of this operation. The effect produced was so noticeable that the population increased visibly from that time. At the end of 1897 there were 127 vaccinators scattered in the different provinces of the archipelago and subject to an institute or central vaccination house established in Manila, which consists of a first medical director, a second physician, another provisional one, and 3 orderlies.

COLLEGE OF PHARMACISTS.

This college has been in Manila since 1892. Its object is to defend, protect, and promote professional interests. The idea of its foundation was initiated in a preparatory meeting held by several professors on the 29th of November, 1891, and the project was approved by the decree of the civil governor of Manila the 31st of December of the same year, and the college was inaugurated the 3d of January, 1892.

Its first act was to aid two professors of the science who had met with losses on account of the then recent inundations of Consuegra (Spain), and since then it has done many other works in conformity with the object of the institution.

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[1] Destroyed in the late war

POLICE AND PUBLIC ORDERS.

VARIOUS INSTITUTIONS.

Some time ago the services of police and public order in Manila, and even outside of it, were intrusted to two bodies called "public safety" and "civil regiment," which for reasons that it is irrelevant to explain were dissolved. Exclusively for the services of police and vigilance within the limits of Manila and its suburbs, there was created in 1868 a municipal guard, and on the 13th of December, 1869, the governor-general decreed its reorganization as the corps of vigilance and the creation of the civil regiment, which afterwards became the corps of firemen, as explained later on.

VETERANS.

This body, which has always distinguished itself in this kind of service, on account of its integrity, courage, and constancy, is also called the Veteran Civil Guard. Its creation was proposed in 1871 to the Government of Madrid by Governor-General Izquierdo, and, having been approved, it began to work the 1st of July, 1872, and continued until the end of the Spanish dominion, always preserving the prestige and the sympathy which it gained for itself from the beginning of all the inhabitants of Manila and its suburbs. In 1894 it numbered 413 members, part infantry and part cavalry, but all with the military organization proper to the civil guard, and under the orders of a commander and six lieutenants, in charge, respectively, of six subdivisions.

MUNICIPAL GUARD.

About the years 1894 and 1895, when the offices of civil governor and judge of Manila were separated, which had formerly been united in the person of the mayor, the veterans remaining under the orders of the former, the judge and town council created for the services of vigilance and police at their command the Municipal Guard, composed of a much smaller number than the veterans, and which likewise existed until 1898.

IN THE PROVINCES.

Outside of the city of Manila the services of police and public order in the capitals and other towns were attended to by the provincial governors, in harmony with the head governor of the archipelago.

SECRET SERVICE.

On account of the rebellion which broke out in 1896, a corps of secret police was created by the governor-general to assist the veterans, making use of the advantages offered over that organization by ordinary or unrecognizable clothing, in order to enter, unnoticed and without causing anyone to suspect them, the anti-Spanish meetings or conspiracies.

CIVIL GUARD.

This body, or institution, has for its chief object the capture of the criminals who roam outside of the centers of population in the islands of Luzón and Visayas. In 1855 the governor-general, Crespo, proposed its creation to the Madrid Government, and the project being approved in 1868, the corps was inaugurated in 1869, patterned after that in Spain. It was distinguished from the beginning by its severe discipline and by the martial aspect of its members, and it had in its charge the provinces and districts of Manila, Mórong, Cavite, Laguna, Batangas, Tayabas, Pampanga, Nueva Ecija, Bulacán, and Pangasinán. In view of the useful service which it gave, Governor-General Izquierdo obtained authority to organize another regiment of the Civil Guard, which, with the regulations of the former, began work on the 1st of June, 1872, in the remaining provinces of the island of Luzón. Later a civil guard for the islands of Visayas was organized.

It was, therefore, composed of three regiments. The Twentieth (number of the order relative to those of Spain) exercised its jurisdiction in the north of Luzón, the Twenty-first in the south, and the Twenty-second in the Visayas islands; each commanded by a colonel (first chief), a lieutenant-colonel (chief of battalion), a captain-paymaster, and another adjutant. Besides, there were three districts commanded by commandants, with the necessary lines, sections, and posts. In 1897 the total number of the Civil Guard in the Philippines amounted to 3,561 individuals, according to the Official Guide of 1898.

IN MINDANAO.

In Mindanao the Civil Guard had not yet been established. Its duties were intrusted to the civil regiments; that is, to a militia, which the natives entered by lot (into which the natives were drafted) and under the orders of Spanish officers, with a military organization suited to the people and the country and approved by the head government of the Philippines. It was subject to the politico-military governor residing in the provincial capital, who retained them or distributed them according to the exigencies of the public service.

ARMED BANDS.

In the towns of the archipelago there are also armed bands (cuadrilleros); that is, a fixed number of youths who by weekly turns are in the government house at the disposal of the subgovernor and electors (principalía), for these remaining services of police and public order not intrusted to the Civil Guard or regiments. Their organization is wholly civil, and is subject in everything to the subgovernor, captain, or judge of the town, who is accustomed to employ them in carrying the mails where no special service of communication has been established.

CORPS OF FIREMEN.

The corps of firemen has in charge the service against fires in Manila and its environs. It depends on the municipality, at whose orders it is usually employed on municipal works, together with the municipal laborers. The Civil Regiment, mentioned a short time ago, organized by virtue of the decree of the governor-general on December 13, 1869, to attend to municipal police and vigilance, was on the 14th of January, 1870, the corps first detailed for fire service, and it has existed since that date, with some modifications. In 1871 it was organized for this special service. At the end of 1896 its force consisted of 96 individuals, distributed in four zones, which, together with the 180 municipal laborers, made a total of 276 persons.

PUBLIC LIGHTING.

That used in the archipelago until a short time ago was cocoa oil or kerosene in all the chief towns or capitals of provinces and other important towns.

In the walled city of Manila and its suburbs it was substituted in 1895 by electric light, whose installation, preservation, and other works were carried on by a Spanish company called the Electric Company of Manila. Notwithstanding, the kerosene lamps did not entirely disappear at that time, as is indicated by the table published in the bulletin of statistics of the city of Manila in December, 1896, which is as follows:

Number of electric lights and kerosene lamps in each district and linear extent of the public streets.

Districts.	Electric lights.		Kerosene lamps.	Total.	Linear extent of public streets.
	Arc.	Incandescent.			
					Meters.
Intramuros	46	174	....	220	10,708
Binondo	22	114	....	136	3,806
Santa Cruz	12	165	....	177	14,781
Tondo	4	79	9	92	11,944
Quiapo	14	113	....	127	10,534
San Miguel	12	60	....	72	8,600
Sampaloc	6	45	2	53	4,165
San Fernando de Dilao	....	6	154	160	10,895
Ermita	13	67	150	230	5,470
Malate	7	....	77	84	6,915
San Nicolas	4	177	....	181	8,392
Walks and gardens	....	....	....	....	8,070
Total	140	1000	392	1,532	104,280

At the present time the company has 6 large engines of 300 horsepower each, with 8 Galloway boilers, which put in motion 12 dynamos, capable of developing a potential of 2,080 volts of 30 amperes each, therefore sufficient to supply the current required for 30,000 lamps of 16 candlepower. Eight of these dynamos are alternating, for the incandescent lamps, and 4 continuous, of the Brush system, for the arc lights, and they furnish the public and private lighting of Manila and its suburbs.

Eight circuits start from the distributing board of the central station and they cover a distance of 50 kilometers, more or less, since only the circuit which goes to the limits of Malate measures some 9 kilometers and the rest go out on an average of 5 kilometers.

In spite of this, the number of new electric lights is so great that said machines exhaust their power in developing the electric current contracted for, and the company came near being obliged to request the postponement of the introduction of new lights until the arrival of two new engines of 500 horsepower, with dynamos capable of creating a current for 12,000 more lights or lamps, which will not only supply them, but will permit of electricity being applied to the solution of industrial and domestic problems, until now untried in the Philippines, such as for washing, ironing, sewing, printing, lithographing, the manufacture of cigarettes, and other work which does not require powerful motors.

The School of Arts and Sciences of Iloilo introduced electric lighting June 1, 1895. The dynamo was of continuous current, of the Brown type; it had 12,000 watts, and developed a tension of 110 volts. But on account of lack of power in the motor it was impossible to feed the incandescent lamps put in the building, for which reason some otherwise indispensable lights were disconnected.

APPENDIX.

PHILIPPINE EXPOSITIONS.

We do not believe that we can conclude this treatise on the state of culture in these islands in a better way than by briefly describing these two splendid manifestations of it, still recent and very apropos, to prove with facts the perfect conception which we have tried to give in this book.

GENERAL EXPOSITION OF THE PHILIPPINE ISLANDS IN MADRID.

The Philippines had won laurels in all the international expositions held in this century, and especially in those of Philadelphia and Amsterdam, where, on account of the importance of her exhibits, they had been given preference among the colonies there represented.

To make known to all Spaniards what the Philippines were accomplishing in the various branches of agriculture, industries, and commerce, and in all the various products of labor, the Government of Spain decreed that there should be opened in Madrid a general exposition of the Philippine islands, including under this name and for this occasion the products of the towns and territories which were subject to the general government of the Philippines, and consequently, also, the Marianas, Palaos, and Caroline islands.

The exposition was inaugurated the 30th of June, 1877, in Campo Grande. It was divided into 82 groups, comprised in the 8 following sections:

(1) Geography, meteorology and terrestrial magnetism, orography, hydrography, anthropology, biology, geology, and mineralogy (groups 1 to 13).

(2) Indian dress, customs, and manners (groups 14 to 22).

(3) Army and armed auxiliary forces of the Government (groups 23 to 29).

(4) Navy (groups 30 to 35).

(5) Botanical geography of the archipelago, flora, forestry, and fauna (groups 36 to 43).

(6) Agriculture, horticulture, and fisheries (groups 44 to 47).

(7) Industries, commercial movement, and traffic (groups 48 to 68).

(8) Public and private works, printing, public instruction, sciences, and arts (groups 69 to 82).

The premiums awarded were of five classes, viz.: (1) Diploma of honor; (2) gold medal; (3) silver medal; (4) bronze medal; (5) honorable mention.

According to the judgment of an expert, among these sections the second was the most curious, if not the most original; the fifth, the most interesting and complete; the sixth, the most important and the richest of all.

LOCAL PHILIPPINE EXPOSITION.

The great success of the General Exposition of the Philippines, of which we have just spoken, and later, in the Universal Exposition of Barcelona, was a stimulus for the local one of this archipelago, decreed by the Madrid Government and inaugurated in Manila the 23d of January, 1895. The products of the Marianas, Palaos, and Caroline islands also appeared in this exposition. It embraced the six following sections:

(1) Orography, hydrography, geology, anthropology, mining, metallurgy, and meteorology (6 groups).

(2) Implements, fishing industries and manufactures, flora, forestry, and medicinal plants (10 groups).

(3) Agriculture (14 groups).

(4) Trades and manufactures (14 groups).

(5) Commerce and transportation (11 groups).

(6) Fine arts (11 groups).

(7) (Not assigned in the programme.) Periodical press, normal school for teachers, park, military sanitation, etc.

The rewards were altogether 1 diploma of honor, 6 diplomas of merit, 24 gold medals, 48 silver medals, 96 copper medals, 192 honorable mentions, and an undetermined number of cooperation medals of gold, silver, and copper.

The result surpassed all expectations.

189745

PAPER NO. XIV.

BENEVOLENT INSTITUTIONS.

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BENEVOLENT INSTITUTIONS.

It would be a difficult task to describe the many establishments and associations belonging to this class in all the Philippine Archipelago, and especially in the capital. Omitting mention of the military hospitals and the benevolent institutions founded in the Marianas, Caroline, and Palaos islands, dependent until a short time ago on the general government of the Philippines in its character of vice royal patron of the churches of Asia founded in the Spanish dominions, and passing by some colleges and centers of learning elsewhere described, which on account of the object of their foundation are true and not insignificant benevolent works, we reduce this sketch to the three following paragraphs: Hospitals, almshouse asylums, other analogous benevolent institutions.

HOSPITALS.

We shall briefly describe five hospitals, some of them in the city of Manila, others outside of it. However, we do not pretend to assert that these are the only institutions of this kind established in the Philippines. They are the following: Hospital of San Juan Dios and the Hospital of San Lazaro, in Manila; Hospital of San José, in Cavite; Leper Hospital, of Cebu, and, finally, the Leper Hospital of Palestina, in Camarines Sur.

Hospital of San Juan de Dios.—This was the first establishment of its kind, and is one of the most important institutions in the capital of the archipelago.

It was founded in 1596 by the Brotherhood of Santa Misericordia, for the care and assistance of poor, sick Spaniards in private life. In 1656 the brotherhood ceded it to the monks of San Juan de Dios, in whose charge it remained until 1866, when they were succeeded by the Sisters of Charity. In the same year, 1866, the government created the inspecting board charged with its direction and administration. It has passed through many vicissitudes. The horrible earthquake of 1863 ruined it almost completely, and what remained was overthrown by the earthquake of 1880. Later large sums were spent to repair the damage which the tornado of 1882 caused in the whole edifice, which was being partially rebuilt with the funds supplied by the generosity of governors-general, of pious persons, and especially of the archbishop.

The income derived from the pious legacies which the hospital had in the beginning was in a great measure lost in the course of time on account of the frequent wars and political changes which have afflicted this country. Recently it only depended on the income from four or five houses and three country places in Manila and its suburbs, and

2,000 pesos which it received for the cure and support of sick Chinese. The rents of the plantation of Buena Vista, in Bulacan, are what principally supports it. It formerly depended, also, on the vice-royal patronage.

The number of beds was not indicated at its foundation, and was as follows:

	Beds.
2 wards for Spaniards and foreigners	30
1 medical ward called San Rafael	90
1 surgical department	65
1 women's department, divided into 2 wards, medical and surgical	80
1 Chinese department, divided into medical and surgical wards	75
2 infirmary wards for the fort and prison of Bilibid	80
2 isolated wards for contagious diseases	25

In normal times the greatest number of patients was 462 and the least 373.

The staff engaged in the service of the establishment is as follows:

Head administrator	1
Managing director	1
Physicians	6
Apothecary	1
Mother superior and Sisters of Charity	23
Chaplains	2
Architect	1
Head nurse	1
Medical students (internes)	8

Besides the number of experienced orderlies and apprentices which the service requires. There were 436 patients at the beginning of 1897, among them 241 Indians.

Hospital of San Lazaro.—This hospital was begun in 1578, on the occasion of the venerable Juan Clemente, lay brother of San Francisco, devoting himself to gathering together and curing sick people at the gate of his convent in Manila. As the number of these increased he constructed for them two wards of light materials with the alms which he collected and the work of those who could do it. Twice it was destroyed by fire and as often rebuilt. The third time it was built of stone outside of Manila, and it was destroyed so as not to provide a fortress for the Chinese pirate Kogson. Rebuilt on the same site, it was ordered to be destroyed again on account of the damage done to Manila by the battery set up in it by the English in the eighteenth century. Finally it was erected on the present site of Mayjaligue in 1788. It was in charge of the Monks of San Francisco and in it leper patients sought refuge and were maintained by a certain sum appropriated in the provincial budgets, by pious legacies, and by the alms of benevolent people. At the beginning of 1897 there were 152 Indian patients.

The Hospital of San Jose, in Cavite.—The Hospital Brotherhood of San Juan de Dios founded this hospital in Cavite in the year 1641, in the royal houses which were then in existence, with the alms of pious persons. With these and the great zeal of those monks some beds were soon provided.

Recently the internal administration was in charge of one medical director, one treasurer, one chaplain, three Sisters of Charity, one apothecary, and two orderlies. It depended upon the viceroyal patronage. Lately there were two other Sisters of Charity to take care of a girls' school founded in 1890 in the lower story of the same establishment.

Leper hospital in Cebu.—Bishop Jimeno, of Cebu, built this in 1850, and it was under the immediate direction of the prelate of that diocese. It was a building of stone with a tile roof, located outside the walls of the city on the north and in an open and hygienic place. It had capacity for 100 sick men and women, with their respective apartments, and was supported by local funds and alms. The interior administration was in charge of the Sisters of Charity. (See what is said about the house of charity of Cebu.)

Leper hospital of Palestina in Camarines Sur.—This hospital was founded in 1872, near Nueva Caceres by the illustrious Bishop Gainza of that diocese, with charitable collections and a moderate sum from the proceeds of a pious legacy in favor of this hospital which had been accumulating for several years.

It was maintained with the annual revenue from said legacy and a Government appropriation charged to the local funds of the provinces of Tayabas, Albay, and Ambos Camarines, for whose sick this hospital was intended.

Recently and in normal times there were some 85 patients of both sexes, lepers, bodily and spiritually cared for by the Franciscan fathers, who with this object administered the hospital from its foundation.

ALMSHOUSE AND ASYLUMS.

We have to describe one almshouse and three asylums—the royal almshouse of San Jose; the male orphan asylums of Tambobong, the female orphan asylum of Mandaloya, and that of San Vicente de Paul.

THE ROYAL ALMSHOUSE OF SAN JOSE.

This was founded in 1810 by the royal decree of 1806 with the proceeds of pious bequests left at their death by several individuals. It was closed on account of difficulties and lack of funds and reestablished in 1828, aided by public funds greater or larger according to the times and vicissitudes, with the object of maintaining, sheltering, and assisting the poor children and insane persons who were sent from the provinces of the archipelago by the competent authorities. In 1889 the Government appropriation was increased. It depended upon the viceroyal patronage; and for its internal management it had a medical director, a treasurer, a chaplain, three Sisters of Charity, one apothecary, and two orderlies. At the beginning of 1897 it had 548 inmates.

MALE ORPHAN ASYLUMS OF TAMBOBONG AND FEMALE ORPHAN ASYLUM OF MANDALOYA.

The principal ladies of Manila, taking pity on the many orphans of both sexes left by the cholera in 1882, with the approval of the Government and the alms of pious persons, founded a temporary asylum for the benefit of said orphans, under the title of "Nuestra Señora de la Consolación" and "Santo Tomás de Villanueva" With the object of making the institution permanent, they first offered its management, and later, for lack of means, its support also, to the Augustinian fathers (not barefoot), who in 1885 took charge of everything relating to the support, instruction, and education of the children of both sexes already received or to be received in future.

The boys were temporarily transferred to the Convent of Guadalupe in 1885, and in 1890 permanently to the town of Tambobong, Longos ward, in the province of Manila, where they receive primary, elemental, and superior instruction, and a Christian education, and at the same time they are taught a trade by which they can later earn an honest living.

Those monks ceded to the girls temporarily the property in Mandaloya as soon as they had brought from Spain the Tertiary Augustinian nuns to look after their instruction and education. This arrangement was soon made permanent and was approved by the Government; and the girls learn in the institution to read, write, figure, sew, embroider, wash, and to do all the other work required of a poor woman who has to support herself by her work.

The orphans of both sexes are admitted into their respective asylums on certain conditions, and recently they numbered 100.

ASYLUM OF SAN VICENTE DE PAUL.

This is located in San Fernando de Dilao, in the ward of Looban. The building was the property of a Sister of Charity, who donated it and some real estate to the same community for the purpose of receiving and educating in it about 30 poor girls. Others are admitted on the payment of a moderate pension. Recently the total number of girls amounted to 180, in charge of the same Sisters of Charity.

OTHER ANALOGOUS BENEVOLENT INSTITUTIONS.

HOUSE OF CHARITY OF CEBU.

This house, recently founded in the city of Cebu, which is at the same time a college, school, hospital, and almshouse, is subject to the bishop of Cebu, and under the immediate direction of the Sisters of Charity.

ROYAL HOUSE OF MERCY.

The Brotherhood of Misericordia founded this in 1594 for the purpose of doing deeds of mercy through the alms of the members. Among the works projected that which prevailed was taking destitute Spanish orphan girls to bring up and educate, and for this purpose the College of Santa Isabel was erected.

The many girls who were soon admitted were maintained by the alms of the members alone until 1640, when the first bequest was made, and soon after many others devoted to the same object. Later the resources diminished to such a degree that if, about the year 1880, Archbishop Payo had not transferred some pious legacies to this college it would have disappeared altogether.

On account of identity of purpose, the Government in 1861 added to this college that of Santa Potenciana, with its respective income and funds.

At present it is supported by the sums which it receives as one of many participants from the appropriation for pious works and by the pensions of some boarding pupils, half pensioners, and outside paying pupils.

In describing the institutions of learning, we spoke more fully of this college and of that of Santa Potenciana, which was added to it, because that was the most appropriate place for it. For the same reason we shall say nothing here of other institutions which, although on account of the object of the founders and the way they are supported, are really charitable works, yet are rather centers of learning and education, namely, the Royal and Pontifical University of St. Thomas, the colleges of St. Thomas, St. John Lateran, St. Joseph, and St. Catherine.

Finally, we shall not undertake to describe here some associations which, practicing certain works of charity toward their neighbors, are notwithstanding essentially religious in character, such as the Venerable Third Order of Santo Domingo, the Venerable Third Orders of San Francisco, of Manila, and of Sampaloc, the Arch-Confraternity of Nuestro Padre Jesus Nazareno in the Church of the Padres Recoletos, the monasteries of the Society of Jesus, of Santa Rita in Pasig, of San Sebastian in Calumpang, the monastery of Santa Clara, the Arch-Confraternities of the Sanctísimo Sacramento de la Catedral, and of Binondo, that of Nuestra Señora de la Consolación and Correa, the Venerable Congregation of the Priests of St. Peter the Apostle, all established in old times by virtue of some pious bequest in the walled city of Manila or in its suburbs. They may be seen in the first part, entitled "Religion."

COUNTRY INSTITUTION FOR RESCUED CHILDREN IN TAMONTACA (MINDANAO).

The first missionaries of the Society of Jesus, who, on their second coming to the Philippines, left Manila for Mindanao in 1861, earnestly desired and succeeded in gathering together some children, chiefly of the Moro race or their captives, to educate them suitably so as to rear a new Christian generation in the midst of the country of the Moros. Little was accomplished, however, until 1872. Then the Fathers, having acquired the necessary land in Tamontaca, and having obtained the protection of Mr. Golfin, the politico-military governor of Mindanao, on the occasion of the famine which afflicted the valley of the Rio Grande, easily ransomed from the Moros many children of both sexes using the alms which the chief authorities of Manila and a board constituted for this purpose sent them. Having made this beginning, the mission of the society continued the work on their own account according to their means.

The freed boys received in the institution were subject to the discipline and direction of the fathers and brothers of the society, and there they were provided with everything necessary. If they were infants they were promptly baptized; and if adults they instructed and prepared them, having previously ascertained their desire for baptism. They heard mass every day, confessed and communed generally every three months, and observed a common distribution of time, and learned the catechism, good manners and customs, to read, write, and speak Spanish, and to work in the fields or in some other occupation, according to their strength, so as to become useful and honest men on leaving the institution.

The girls lived in a separate building, not far from the Mission House, consigned to the care of the mothers of the nunnery of the Society of Jesus, who went there from Manila for that purpose, and they were all subject to the missionary fathers. They followed a regime similar to that of the boys, and learned to read, write, and do work proper to their sex, the practice of which they needed to know when they left the institution.

On reaching the proper age the mission father inquired the will of the wards, and if the contracting parties were willing they made their houses, which they then occupied as married people, aided with a water buffalo and implements of agriculture and maintenance for one year at the expense of the institution. Almost all the people of Tamontaca came from these marriages.

The number of boys or internes in the institution used to be from 70 to 80, and that of girls from 60 to 70, including some adult persons not redeemed, but who had entered voluntarily. The annual average of redeemed children was about 28; and that of new pupils received, 8, because the many ordinary expenses and those necessary for erecting and enlarging the two houses and church, and those caused by two fires which occasioned great losses, did not permit more. Besides, the institution became in times of famine, and for all the necessities of the town and even of the neighboring ranches of all that district, a veritable almshouse.

CHARITABLE PAWNBROKER ESTABLISHMENT AND SAVINGS BANK.

Although the Government of Madrid ordered in 1860 the founding of a charitable pawnbroker establishment, notwithstanding so many difficulties arose that it could not be realized until the 21st of July, 1880, when it was opened on the ground floor of the Royal College of Santa Isabel, by making use of the sum of some legacies for pious works, whose administration was in charge of the Royal House of Mercy. Later it was installed in a new building in the center of the capital.

It was dependent upon the viceroyal patronage and was managed by a council of administration, of which the archbishop was the president. For its internal management, it had a managing directer, a cashier, a treasurer, three helpers, and two appraisers. It had its by-laws.

It lent money at 6 per cent interest annually, or one-half of 1 per cent per month on jewels, which could be redeemed at any time of the year when due and renewed when this time came. They also accepted deposits in the savings bank, which drew interest at 4 per cent annually, counting from the week following the one in which the deposit was made, which, if in the name of a single person interested, only drew interest on amounts not exceeding 1,000,000 pesos, which was subject to some variations.

The sales of jewels at public auction were held on the 10th and 11th days of each month.

CONFERENCES OF SAN VICENTE DE PAUL.

The members of San Vicente de Paul visit, two by two, weekly the homes of the families which the conferences adopt, making use of temporal alms to better impart the spiritual help they may need.

In 1860, Father Cuevas, of the Society of Jesus, its spiritual director, founded the intramural conference, called La Immaculada. There were established successively in the suburbs of the capital: in 1885, those of Binondo and Santa Cruz; in 1886, those of Tondo and Ermita; in 1887, that of Quiapo; in 1899, that of San Miguel; in Mindanao, in 1892, that of Zamboanga, and in 1894, that of Cottabato.

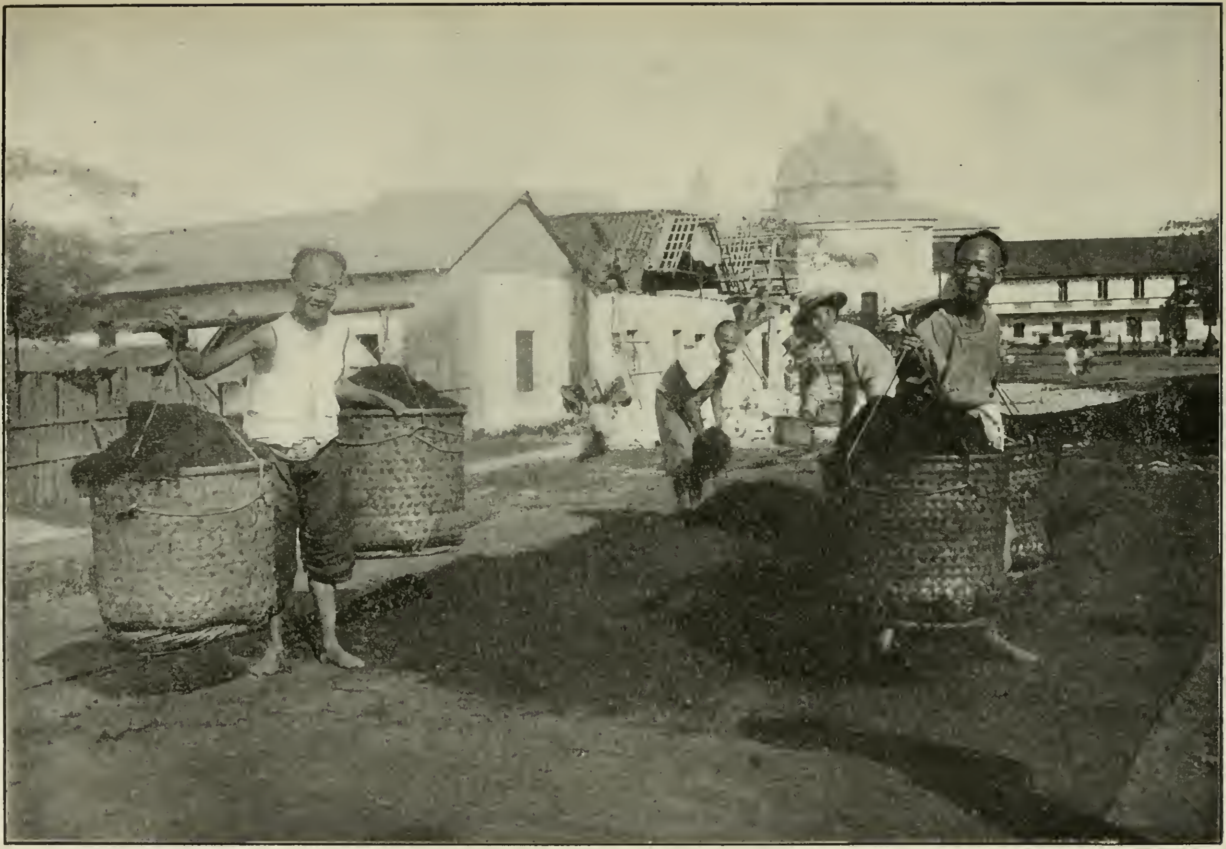
They are all subordinate to the central council of Manila, always subject to the spiritual direction of a Jesuit father.

The council has also instituted other beneficent works besides the conferences, although under their patronage and direction, among which are worthy of mention: The Patronage of Widows and Orphans (1886), carried on by ladies of the best society, who assist them with liberal donations, and dependent on it the asylum for homeless girls; the carpenter shop and cabinetmaking shop for boys and youths of the working class (1886)—these ceased to exist years ago; another of matrimony (1887), which occupies itself in canonically regulating illicit unions. At one time it also undertook to distribute catechetical tracts.

PAPER NO. XV.

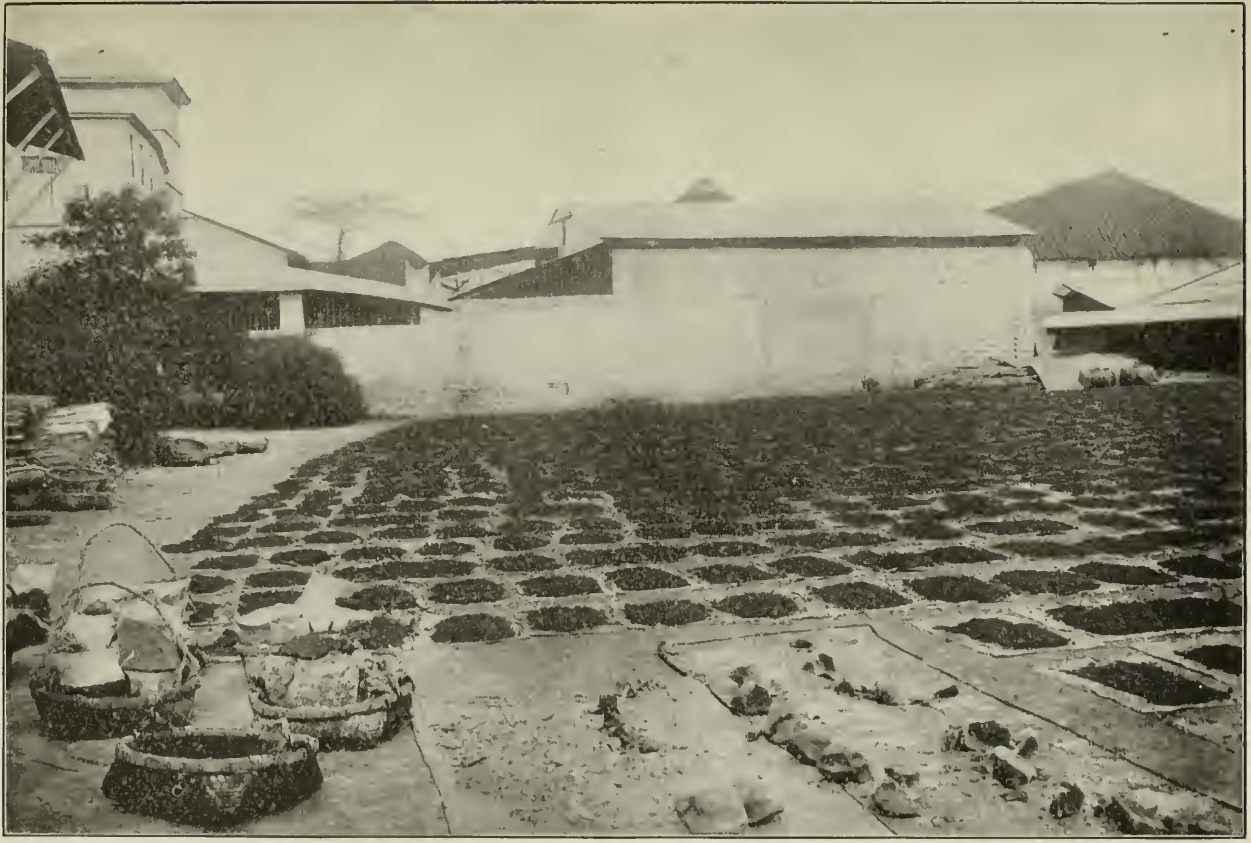
STATE OF INDUSTRY.

PLATE I.



CHINAMEN CARRYING AND DRYING TOBACCO FOR CIGARETTES.

PLATE II.



DRYING SUGAR.

STATE OF INDUSTRY.

AGRICULTURAL INDUSTRIES.

THE TOBACCO INDUSTRY.

This is without doubt the principal Philippine industry which, on account of the excellence and cheapness of its products, can compete with those of more advanced nations. In general it may be said that the tobacco industry since the abolition of the monopoly has increased in all regions to an extraordinary degree, both in the quantity and quality of the product. As a result the Havana methods of gathering and curing the leaf and manufacturing the product have become popular throughout the country. ✓A full knowledge of the fermentation or preparation of the leaf is still lacking, or perhaps this work is carried out under poor conditions, so that the leaf does not have the aroma and strength of the Havana. In many parts of the islands the manufacture of tobacco is carried on with modern machinery. More women are employed in the tobacco factories than men.

The samples of manufactured tobacco shown in the General Exposition of the Philippine Islands in 1887 indicated great advances in the manufacture of this product. The beautiful containers in which this tobacco was exhibited followed the models of those used in Cuba.

The General Tobacco Company of the Philippines has a factory in operation near Manila known by the name Flor de la Isabella. This building has 12,000 square meters of floor surface and gives employment to 4,000 persons—almost all women. This factory uses the best of selected tobacco from Isabella and Cagayan. The cigarette machines in this factory are worked by steam. All of the containers used are made here and all the labels are printed here. The factory communicates with the Pasig River by a canal crossing the company's land, which was opened at the company's own expense. The company owns in the Province of Isabella two important plantations, which produce tobacco of a superior grade, due to the vigilance shown in cultivating and gathering. In all the towns in tobacco-producing regions of the Philippines the company has agents, these being dependent upon a central agent in each province.

THE SUGAR INDUSTRY.

✓In the manufacture of sugar the best methods are not generally employed. The natives extract the juice by means of mills of stone, wood, or iron; these being called trapiches. The juice is then collected and boiled in kettles, a little lime being added to purify it. When the boiling has reached a certain point, which is recognized by those who are expert, it is passed on to a second kettle, where the boiling is continued until it reaches a certain temperature. It is then poured into conical molds which are placed upright so that the molasses may drain off. These molds are placed over small jars, where they remain until the sugar has formed, it now being free from molasses. It will be seen therefore that there is great opportunity for improvement in these methods. In Negros and Pampanga there are many iron mills worked by animal power, water, or steam.

In Manila there are two large sugar refineries, the Clementina, belonging to the General Tobacco Company, and another establishment in Malabon.

THE HEMP INDUSTRY.

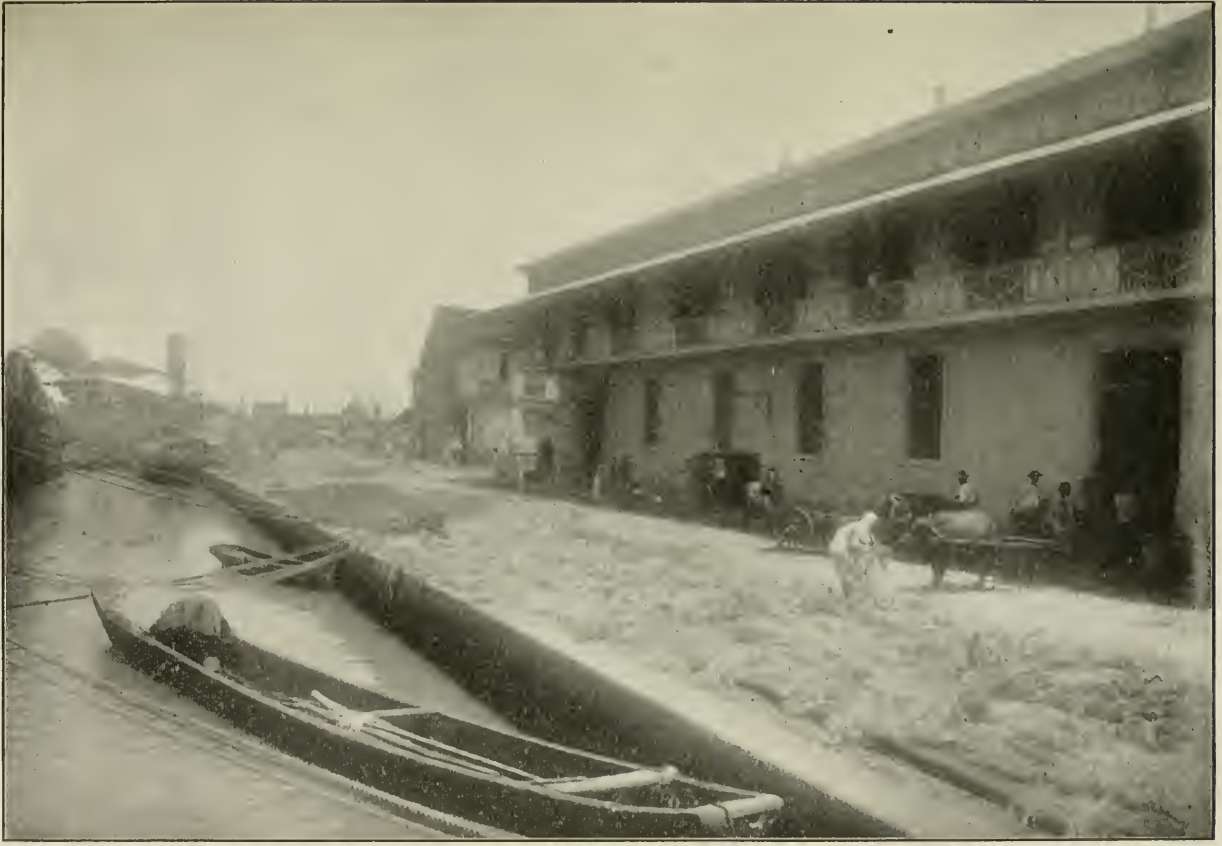
For extracting the fiber from the sajas or long strips of the plant a very simple apparatus is used. This consists of a sharp, somewhat dentate knife fixed above a smooth piece of wood. One end is fastened by a pivot; the other end, extending beyond the wood, has a cord and weight attached to it, so that the knife is kept in close apposition to the wood. Another cord attached to the knife runs over a pulley and then downward, being attached to a pedal. Pressure on this pedal raises the knife so that the saja may be inserted. The fiber is now pulled out, the fleshy part of the plant remaining behind. The saja is now reversed so as to clean the other end. With this machine a workman can clean 35 or 40 pounds of hemp a day. The hemp is then placed in bundles in the sun to dry, so as to prevent the putrefaction of the cellular tissues still adherent to the fiber. When thoroughly dried it is ready for the market. The fiber from the same plant presents marked differences in strength, solidity, and luster. That from the outer part is coarse, strong, and reddish in color, and is known as bandala ordinaria. It is employed largely in the manufacture of heavy rope.

Fiber from the middle layer, the ordinary hemp of commerce, is called bandala, while that coming from nearest the heart of the plant is very white and of superior quality. This is called lupis in Albay and quitoti in Marinduque. The latter two which are firm, lustrous, and flesh colored, are largely employed for the manufacture of fabrics. It is found in the market in bunches or bundles called pilihan. The natives classify this hemp in four ways, according to its quality, as binani, tonga, cadaraclan, and tinunguos. Fabrics are made from the first kind so delicate as to compare favorably with pineapple cloth. The fiber, tied at the ends into small knots, is wound into bundles and beaten with a mallet against a hollow piece of wood so that it may become more elastic.

THE INDIGO INDUSTRY.

The production of indigo was formerly of much more importance than now. The method of making it in this archipelago will now be spoken of. This includes several operations, maceration in water, the addition of lime, shaking or stirring and decantation of the water, formation of the indigo into masses, and wrapping. After the plant is cut and made up into bundles it is taken to the factory. This is composed of various parts. In the first there are two or more cylindrical or conical receptacles made of masonry or wood, each being 2½ meters in height and 2 in diameter. These are called machos. In the second, called hembra, there is a receptacle double the capacity of those already

PLATE III.



DRYING HEMP (MANILA).

mentioned which is cylindrical in shape, wider than it is high, the sides somewhat inclined, and having two faucets at different heights on the side, through which the impregnated liquor can flow; in the third a receptacle, made of masonry, which is in circular form, a meter and a half high and a meter in diameter, into which the indigo paste coming from the hembra is placed, in order to separate the water from it, and lastly the secadero, where the indigo is exposed to the air and afterwards dried.

Maceration is the first process. The receptacles called machos are filled four-fifths full of water and the bundles of indigo immediately thrown in them. A grating of bamboo having weights attached is now lowered 4 or 5 inches below the surface of the water, the plant being allowed to macerate for twenty-two hours, during which time the leaves undergo a sort of fermentation, liberating the indigo which is held in solution in the water. During this operation the water first becomes yellowish in color, then yellowish-green, and finally green with a yellowish tinge. The maceration being complete, lime is added. In this operation the grating is first removed and the plants taken out after being allowed to drain on the sides of the receptacle. Baskets of quicklime are then lowered into the water, when the liquid immediately changes from green to greenish-blue. It is then drawn off immediately by means of the faucets, beginning with the upper one, and passed on to the hembra or second receptacle by means of little troughs. In the hembra the liquid is stirred with sticks, thus exposing it to the air so that the indigo becomes insoluble. This operation lasts from half an hour to an hour. At the end of the operation the water is bluish-brown in color. It is allowed to remain until more water is added from the first receptacle, when the same operation is repeated. The indigo deposited is now allowed to remain fifteen or twenty days, when it is transferred to the third receptacle. Here it remains for two or three days, becoming separated from the greater part of the water which it contains, this being drawn off by the faucets.

In this place the various grades of indigo become distinguishable, the upper layers containing the superior grade. the central layers the medium grade, and the lower layers the inferior grade. The indigo is now placed in bamboo boxes, having a layer of cotton in the bottom so that the water may drain through. At the end of two days the mass is kneaded by hand into cakes or balls, which are placed on mats arranged on benches in the drying room. Here the drying process continues for five or six days, the indigo being placed in the sun as often as possible, so as to advance the process more rapidly. The mass is now cut with bamboo knives into the proper size, which is usually about 6 inches in length by half as much in depth and height, the corners of the cake being rounded off with the hand. After the cakes are dried they are placed in wooden boxes, where they are kept ready for the market.

MANUFACTURE OF ALCOHOL.

The crude materials which are here used for the manufacture of alcohol are very cheap. They are the juice from the nipa palm and from the cocoanut palm and low grade molasses. In Manila there are four large accredited distilleries, while smaller ones are found both in Manila and in the provinces. Nipa wine is manufactured in Dagupan, in the province of Pangasinan, in Vigan, in the province of South Ilocos, and in Capiz, in the province of Capiz, Panay Island. In all the archipelago there are not less than 500 stills. All the alcohol manufactured is consumed in the country.

MANUFACTURE OF OIL.

✓ A great deal of oil is extracted from the millions of cocoanuts which are grown in the Philippines, although the methods employed are in general quite rudimentary. Other oils extracted are lumbany, castor oil, and those from other plants. Much remains to be done in this industry, not only in perfecting the apparatus employed, which is in general very imperfect, but also in the exploitation of certain plants such as the peanut, which furnish excellent oil. Among the many essential oils useful for the manufacture of perfumes, almost the only one of commercial importance is the ilang ilang, although a little sampagita and champaca are manufactured.

RICE CLEANING.

The primitive apparatus called the lusong is about the only one employed in the Philippines for cleaning rice. The lusong is simply a large wooden mortar in which the rice is pounded until the husk is removed. One or two steam mills have recently been installed.

SOAP MAKING.

Soap has been made in these islands for a long time, but the methods employed are most primitive. The industry is not large in spite of the abundance of suitable material found in the country.

FECULAS OR STARCHES AND FLOURS.

This industry is carried on but little, although the abundance of material found in this country might furnish employment to a large number of people.

MANUFACTURE OF PAPER.

In spite of the abundant raw material found in this country no paper mill exists.

CHEESE MAKING.

Cheese is made in small quantities, that coming from Cebu being of excellent quality.

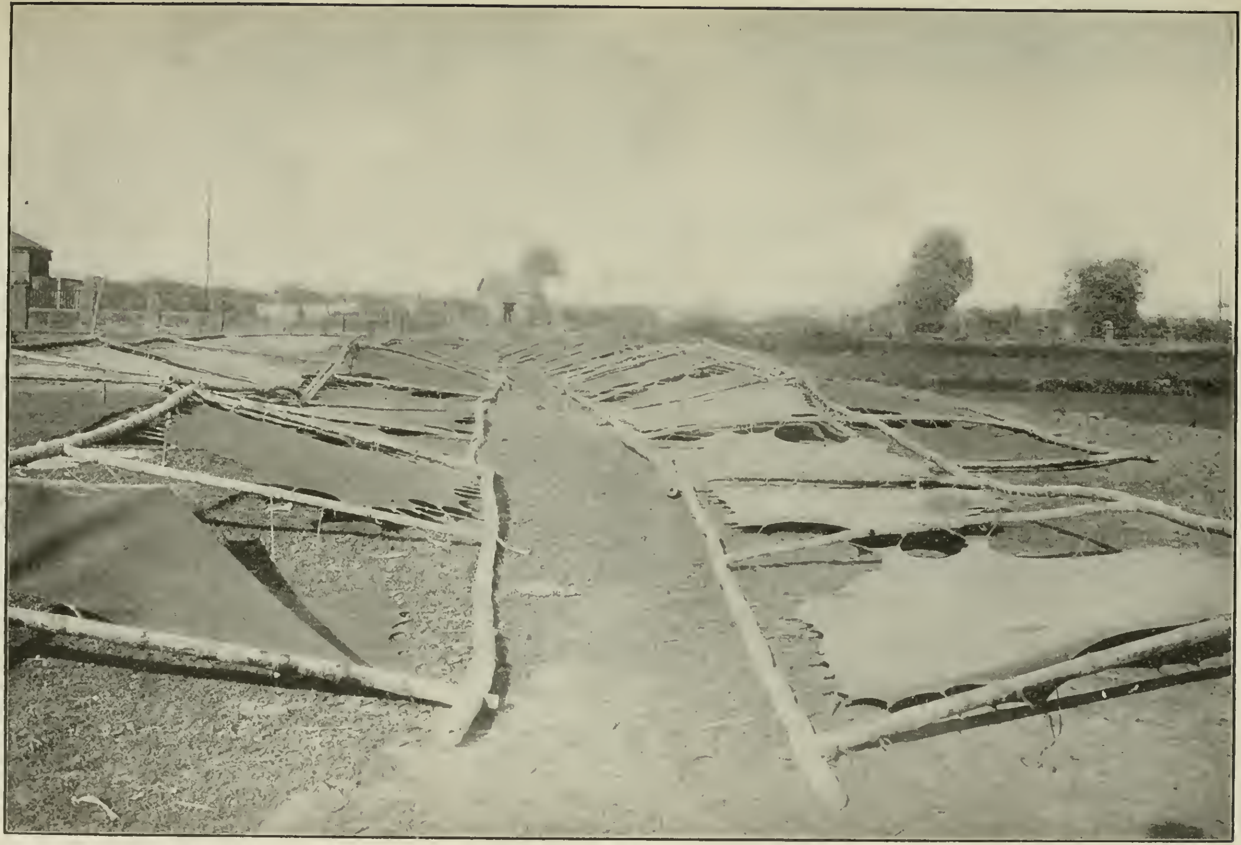
MANUFACTURE OF LEATHER.

This industry is but rudimentary, although considering the large number of cattle found in the country it might be made of some importance.

SILK RAISING.

The silkworm was formerly raised in the Philippines, but is not at the present time. D. Jose Montero Vidal, in his book on the Philippines, says:

> The mulberry (mocus alba) has existed in the Philippines since 1593, when it was planted throughout the Visayan Islands by P. Antonio Sedeno, S. J. Afterwards, in 1780, the Augustin missionary, P. Manuel Galiana, sent this plant from



DRYING CARABAO HIDES.

China, and at the same time eggs of the silkworm. The Royal Economic Society of Friends of the country attempted to encourage this industry, but agriculturists never favored the growth of the silkworm on account of the care involved. So that the industry was almost entirely abandoned. In the time of Governor-General Basco y Vargas there were about 4,500,000 trees in Camarines.

The silkworm flourishes well, and numerous trials in its cultivation prove that it is possible to obtain two or three crops of cocoons annually. The worm which lives upon the castor-oil plant or tangan-tangan resists storms and even typhoons, and although the silk is not of the finest, it has many uses.

COCHINEAL.

The cochineal insect grows well on the plant called dilang-vaca, and when carefully prepared sells well at a good price.

MANUFACTURING INDUSTRIES.

In the Philippines these industries, in spite of the great aptitude of the inhabitants, are not nearly so important as agriculture; due in part to the lack of modern machinery. The most important industries are: The weaving of hemp, pineapple fiber, silk and cotton, and the making of mats, hats, and other articles of fine quality.

HEMP, PINEAPPLE, SILK, AND COTTON FABRICS.

The manufacture of fabrics from these articles has been carried on in the Philippines for a long time on a considerable scale. The natives show great aptitude in this line of work, as is evidenced by the perfection which they have reached, this appearing marvelous when one considers the simple methods they follow and the primitive machinery used. Women are the only ones who work at the looms. The provinces of Albay, Camarines, Ilocos, Iloilo, and Tayabas are preeminent in this line. Señor Martin Martinez, in his review of the exposition, says:

> In all the Philippine territory there is not a machine moved by steam, although there are thousands of primitive looms worked by women by hand and by the most simple methods, which produce a great variety of fabrics suitable for local consumption.
>
> The fibers used in weaving in the Philippines are hemp, pineapple fiber, cotton, and silk. The first two are products of the country. Silk comes from China, and cotton, except a few thousand kilograms grown, cleaned, sponged, and woven in Ilocos, Batangas, and Visayas, comes from England. About 900,000 kilograms in the form of white and colored thread, and having a value of about $900,000, is imported annually. About 8,000 kilograms of silk thread, valued at $120,000, are imported each year from China. In other words, Philippine looms use each year cotton and silk thread valued at more than one million dollars. It is estimated that hemp and pineapple fiber of equal value are annually woven into cloth. It is easy to see, therefore, that an industry which consumes raw material to the value of $2,200,000 annually is of considerable importance.

Cloth made from hemp alone is called sinamay, and though it is somewhat rough, is very cool, durable, and cheap. It is used for making shirts for men and waists and skirts for women. A finer variety of hemp cloth, which is often confused with pineapple cloth, is called tinampipi. A piece 5 yards in length is worth $2, or, say, four times as much as ordinary sinamay. But the especial product of Philippine looms, especially those from the towns of Caloocan and Iloilo, is jusi.

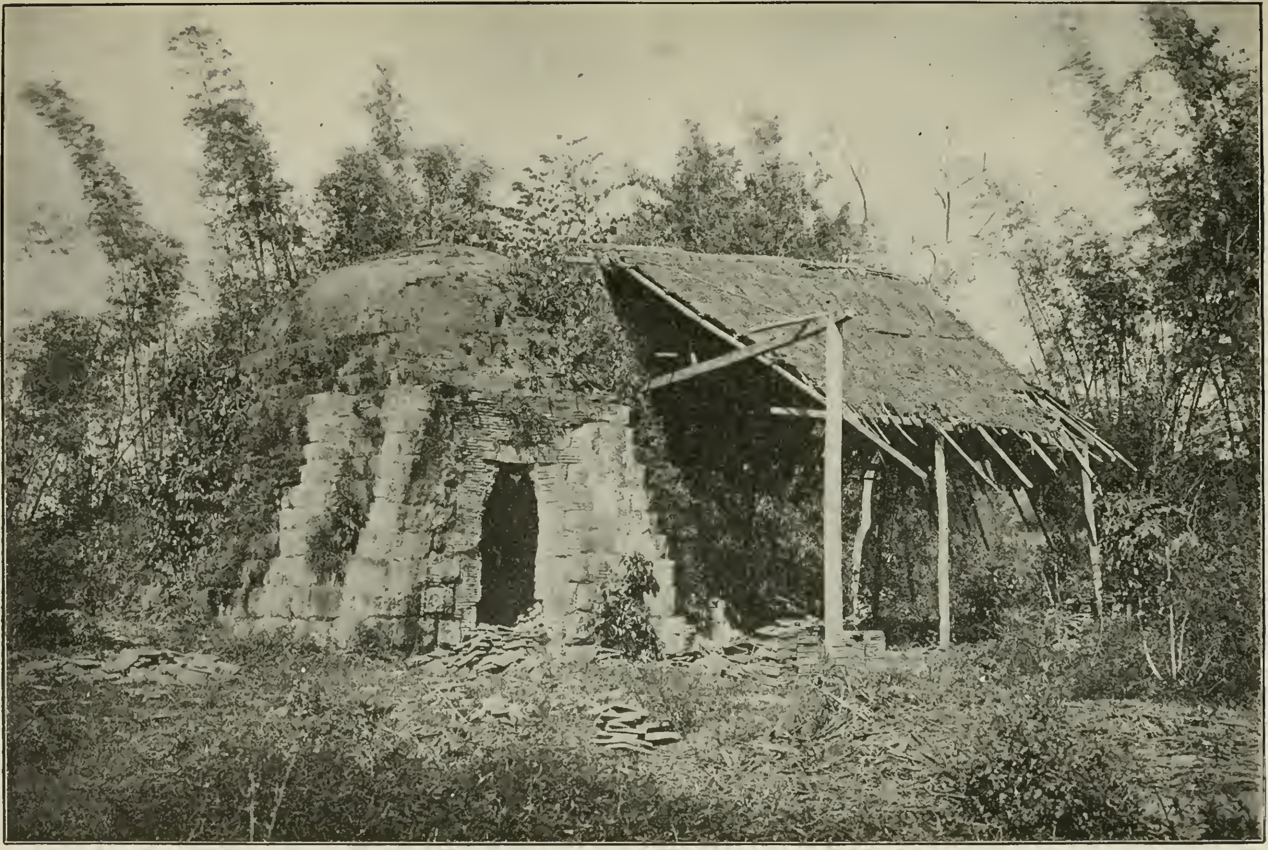
These Philippine jusis, celebrated for their lightness, beauty, and delicate patterns, are made from silk alone, or more commonly with the warp of cotton or pineapple fiber and the woof of silk. Pieces are made to suit the buyer. These pieces are usually 30 or more yards in length and from three-quarters of a yard to a yard in width, and beautifully bordered in colors. This beautiful cloth, which varies in price from 50 cents to $1 a yard, compares favorably with fabrics of European manufacture.

Weavers make from 6 to 25 cents a day and food, according to their ability. The majority of these weavers are girls of from 12 to 20 years of age. This is often a household industry, the two or three looms in the house being worked by the women in the family or by capable servants. In both the Ilocos provinces a specialty is made of the manufacture of heavy cotton blankets. These are much valued in the country, and sell for from $4 to $10 each, according to quality. They are sometimes made of silk, when they may reach a value of $100 each.

MANUFACTURE OF MATS, SLEEPING MATS, HATS, ETC.

✓ The manufacture of mats, sleeping mats, hats, bags, etc., is worthy of mention, because of the intelligence, ability, and patience shown by those who make these beautiful articles. This is the more wonderful when one considers that the only instrument used is a sort of knife called guloc. The materials used are rattan, palm leaves, ferns, and bamboo, all of which are so abundant in this country. The provinces notable for these articles are Bulacan, Laguna, Pampanga, Camarines, Albay, and Iloilo.

PLATE V.



A BRICKKILN NEAR GUADALUPE.

PAPER NO. XVI.

COMMERCE.

COMMERCE.

The statistical and other sources of information with regard to the commerce of the Philippine Islands are far from complete. For certain years rather full data have been found. For other years it has not as yet been possible to obtain them. Nevertheless, much information has been and is being gathered by other departments of the Government.[1]

It is not proposed in this paper to give an exhaustive discussion of the subject, but, making use of the material mentioned above and of the testimony and other information acquired by the commission, it is intended to present only a brief résumé of the commercial conditions of the islands.

For a period of thirty years past, excepting, however, the last five years, the trade of the islands, export plus import, has fluctuated between the amounts of $30,000,000 and $40,000,000 annually, the average lying somewhere between $35,000,000 and $40,000,000. Of this amount something more than one-half represents the value of exports and something less than one-half the value of imports. The excess of exports over imports, fluctuating between $2,000,000 and $6,000,000, may be roughly placed at $4,000,000 on the average.

In the estimates given herein little or no account of the last five years is made, on account of the unusual political and social conditions which have existed, and which have not only disturbed the normal trade, but rendered any accurate account of it less possible.

Of the total export and import trade of, say, $35,000,000, the United Kingdom, China, Spain, and the United States have been the chief beneficiaries for years past. Eighty per cent of the entire trade has been with them. Of this amount the United Kingdom has had by far the largest share, to wit, 35 to 40 per cent of the whole trade of the islands, and to this may still be added a large per cent for the trade between the Philippines and Hongkong, Singapore, and other British possessions in Asia not included in the above estimate, and scheduled, as a rule, as China trade. Spain and the United States, while following next in order of importance in the Philippine trade, have had a much smaller amount of it. In 1881 the Spanish part of the total import and export trade was about 6 per cent; that of the United States about 23 per cent; that of the United Kingdom about 34 per cent, and that of the British possessions in Asia about 35 per cent.

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[1] Bulletin No. 14 of the U. S. Department of Agriculture, Section of Foreign Markets, 1898, contains much valuable information which has been freely used.

Owing largely to the industrial, financial, and tariff measures taken by Spain in behalf of the peninsula, the Spanish trade was very largely increased in the ten years succeeding 1881. At the end of that period the relative percentages of trade enjoyed by the chief trading countries with the islands were as follows: United States, about 9 per cent; Spain, about 18 per cent; the United Kingdom, about 33 per cent, and China, including Hongkong, about 25 per cent.

The following table will show the relative amounts of trade enjoyed by the countries mentioned in 1881 and a decade later (1892–93):

Trade of the archipelago with its chief trading countries in the years 1881 and in 1892 and 1893.

Countries.	Imports.	Per cent.	Exports.	Per cent.	Total imports and exports.	Per cent.
1881.						
British Asiatic possessions	$9,953,207	53.83	$4,054,888	18.54	$14,008,095	34.70
United Kingdom	5,297,873	28.65	8,315,454	38.01	13,613,327	33.72
United States	771,266	4.17	8,217,141	37.56	8,988,407	22.27
Spain	1,365,662	7.39	973,329	4.45	2,338,991	5.80
China	494,274	2.67	60,829	.28	555,103	1.38
Germany	485,767	2.63	....	....	485,767	1.20
French Indo-China	512	....	....	....	730	....
1892.						
United Kingdom	5,196,192	31.85	6,371,119	33.24	11,567,311	32.60
China (including Hongkong)	3,029,940	18.57	5,778,449	30.15	8,808,389	24.83
Spain	4,397,642	26.96	1,839,109	9.60	6,236,751	17.58
United States	208,392	1.28	2,903,648	15.15	3,112,040	8.77
Singapore	987,652	6.05	1,574,910	8.22	2,562,562	7.22
French Indo-China	1,003,074	6.15	181,933	.95	1,185,007	3.34
Germany	527,587	3.23	....	....	527,587	1.49
1893.						
United Kingdom	4,247,883	26.73	9,959,949	44.90	14,207,832	37.32
China (including Hongkong)	2,237,471	14.08	4,866,640	21.94	7,104,111	18.66
Spain	5,104,875	32.13	1,919,253	8.65	7,024,128	18.45
United States	956,706	6.02	2,994,897	13.50	3,951,603	10.38
Germany	1,246,248	7.84	19,728	.09	1,265,976	3.32
France	477,026	3.00	241,844	1.09	718,870	1.89
Singapore	156,135	.98	509,912	2.30	666,047	1.75
French Indo-China	517,933	3.26	5,725	.03	523,658	1.38

The following tables more clearly show the differences in value between the exports and imports of the several chief trading countries for the years 1892, 1893, and 1894:

Countries.	Imports.	Exports.	Excess.	
			Imports.	Exports.
1892.				
United Kingdom	$5,196,192	$6,371,119	...	$1,174,927
China (including Hongkong)	3,029,940	5,778,449	...	2,748,509
Spain	4,397,642	1,839,109	$2,558,533	...
United States	208,392	2,903,648	...	2,695,256
Singapore	987,652	1,574,910	...	587,258
French Indo-China	1,003,074	181,933	821,141	...
Germany	527,587	...	527,587	...
France	272,866	...	272,866	...
1893.				
United Kingdom	4,247,883	9,959,949	...	5,712,066
China (including Hongkong)	2,237,471	4,866,640	...	2,629,169
Spain	5,104,875	1,919,253	4,185,622	...
United States	956,706	2,994,897	...	2,038,191
Germany	1,246,248	19,728	1,226,520	...
France	477,026	241,844	235,182	...
Singapore	156,135	509,912	...	353,777
French Indo-China	517,933	5,725	512,208	...
1894. *a*				
Spain	5,255,000	1,427,000	3,828,000	...
Germany	929,000	14,500	914,500	...
Australia	65,000	1,280,000	...	1,215,000
China	3,382,000	2,300,000	1,082,000	...
United States	364,000	3,690,000	...	3,326,000
France	394,000	617,000	...	218,000
England	3,500,000	4,344,000	...	844,000
Japan	86,000	619,000	...	533,000
Russia	375,000	...	375,000	...
Cochin China	445,000	1,500	443,500	...
Singapore	219,000	843,000	...	624,000
Switzerland	153,000	205	152,795	...

a The original of the tabulation for this year, calculated in pesos, is in this instance turned into dollars at the convenient ratio of two Spanish pesos for one American dollar, and only round numbers are given.

The following table gives the annual values of merchandise, exports and imports combined, of the chief trading countries for the ten years 1887–1896 and the annual averages for the first and second halves of that period:

Total value of merchandise imported and exported by certain countries in their trade with the Philippine Islands during the years (a) 1887 to 1891, inclusive.

Countries.	1887.	1888.	1889.	1890.	1891.	Annual average, 1887–1891.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United Kingdom	7,647,062	14,165,311	19,096,974	13,036,361	15.734,684	13,936,078
United States	10,434,181	10,772,819	11,714,902	5,291,781	6,369,567	8,916,650
Spain	3,802,910	3,934,605	6,052,707	6,472,162	7,021,766	5,457,430
Straits Settlements	1,449,422	1,429,909	1,355,051	1,077,138	885,061	1,239,316
Canada	256,126	906,314	641,273	1,410,183	2,316,948	1,106,169
Germany	(*b*)	(*b*)	1,210,468	945,098	1,034,348	*c* 1,063,304
France	412,049	292,165	600,616	603,766	729,935	527,706
Austria	(*b*)	(*b*)	486,488	564.341	142,753	*c* 397,860
China	416,263	428,187	459,583	323,287	330,517	391,568
Australasia	178,794	200,393	352,380	168,434	237,879	227,576
Japan	104,662	207,347	183,062	369,432	266,721	226,245
Belgium	63,932	107,884	190,006	124,526	88,751	115,020
British India	18,144	11,886	27,722	128,824	174,085	72,133
Netherlands	...	2,067	1,171	1,307	8,164	2,542

a Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. *b* Not separately stated. *c* Annual average, 1889–1891.

Total value of merchandise imported and exported by certain countries in their trade with the Philippine Islands during the years (a) 1892–1896, inclusive.

Countries.	1892.	1893.	1894.	1895.	1896.	Annual average, 1892–1896.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United Kingdom	14,086,800	14,398,781	11,234,243	9,975,892	10,054,296	11,950,002
Spain	8,066,822	7,768,973	8,709,721	8,886,504	11,713,816	9,029,167
United States	9,314,235	7,153,808	4,850,621	5,145,303	4,478,337	6,188,460
France	611,058	781,495	1,132,011	1,472,900	1,965,867	1,192,666
Canada	2,204,454	1,135,577	423,417	864,711	1,242,441	1,174,120
Germany	903,210	1,113,364	789,684	970,088	970,326	949,335
Straits Settlements	836,085	691,020	(*b*)	(*b*)	(*b*)	*c* 763,553
Japan	388,725	418,718	950,106	721,944	1,050,153	705,930
Australasia	249,656	167,183	256,809	196,722	261,292	226,333
China	212,109	189,587	217,011	138,742	116,801	174,850
Belgium	98,093	138,797	86,318	115,659	241,286	136,030
Netherlands	4,148	202,063	177,452	190,396	14,374	117,687
Dutch East Indies	(*b*)	(*b*)	(*b*)	(*b*)	104,801	*d* 104,801
Austria	118,971	66,354	116,159	59,835	51,307	82,525
British India	79,827	61,194	73,288	87,833	78,456	76,120
Ceylon	(*b*)	9,142	6,741	6,117	14,922	*c* 9,231
Hungary	(*f*)	4,423	1,438	608	....	*c* 1,617
Cape Colony	....	....	24	594	1,314	386

a Calender years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. *b* No statistics available. *c* Annual average, 1892–1893. *d* Statistics for 1896 only. *e* Annual average, 1893–1896. *f* Not separately stated.

The following table gives the annual average for the first and second halves of the decade 1887 to 1896 of imports and exports, separately stated and combined:

Average annual value of merchandise imported and exported by certain countries in their trade with the Philippine Islands during the five-year (a) periods 1887–1891 and 1892–1896.

Countries.	Annual average, 1887–1891.			Annual average, 1892–1896.		
	Imports from the Philippines.	Exports to the Philippines.	Total imports and exports.	Imports from the Philippines.	Exports to the Philippines.	Total imports and exports.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United Kingdom	8,729,072	5,207,006	13,936,078	8,844,026	3,105,976	11,950,002
Spain	3,819,426	1,638,004	5,457,430	3,855,165	5,174,002	9,029,167
United States	8,785,988	130,662	8,916,650	6,053,232	135,228	6,188,460
France	185,575	342,131	527,706	986,012	206,654	1,192,666
Canada	1,105,991	178	1,106,169	1,174,068	52	1,174,120
Germany	*b* 175,961	*b* 887,343	*b* 1,063,304	201,158	748,177	949,335
Straits Settlements	528,030	711,286	1,239,316	*c* 345,430	*c* 418,123	*c* 763,553
Japan	161,361	64,884	226,245	616,631	89,299	705,930
Australasia	115,422	112,154	227,576	106,602	119,731	226,333
China	67,735	323,833	391,568	31,710	143,140	174,850
Belgium	6,904	108,116	115,020	27,487	108,543	136,030
Netherlands	95	2,447	2,542	106,451	11,236	117,687
Dutch East Indies	(*d*)	(*d*)	(*d*)	*c* 99,174	*c* 5,627	*c* 104,801
Austria	*b* 361,531	*b* 36,329	*b* 397,860	18,894	63,631	82,525
British India	12,338	59,795	72,133	7,835	68,285	76,120
Ceylon	(*d*)	(*d*)	(*d*)	*f* 9,117	*f* 114	*f* 9,231
Hungary	....	....	....	....	*f* 1,617	*f* 1,617
Cape Colony	....	....	....	386	....	386

a Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years speeified. *b* Annual average, 1889–1891. *c* Annual average, 1892–93. *d* No statistics available. *e* Statistics for 1896 only. *f* Annual average, 1893–1896.

EXPORTS FROM THE PHILIPPINES.

The following tables show the value of merchandise imported from the Philippines by the several foreign countries during each of the ten years 1887 to 1896, with the annual average for the first and second halves of that decade:

Value of merchandise imported by certain countries in their trade with the Philippine Islands during the years (a) 1887 to 1891, inclusive.

Countries from which imported.	1887.	1888.	1889.	1890.	1891.	Annual average, 1887–1891.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United States	10,268,278	10,593,172	11,592,626	5,167,209	6,308,653	8,785,988
United Kingdom	4,275,989	8,220,263	11,347,637	8,018,571	11,782,901	8,729,072
Spain	2,937,237	2,740,715	4,397,241	4,706,957	4,314,979	3,819,426
Canada	256,126	906,314	641,273	1,409,543	2,316,699	1,105,991
Straits Settlements	461,994	710,369	648,103	484,466	335,219	528,030
Austria	(*b*)	(*b*)	447,128	530,184	107,282	*c* 361,531
France	142,919	38,504	100,415	175,659	470,377	185,575
Germany	(*b*)	(*b*)	93,058	116,620	318,206	*c* 175,961
Japan	100,080	156,253	165,837	208,477	176,159	161,361
Australasia	74,622	108,105	215,874	87,553	90,955	115,422
China	79,866	76,542	78,490	47,830	55,946	67,735
British India	18,139	9,469	13,494	14,875	5,711	12,338
Belgium	2,497	7,871	8,792	80	15,278	6,904
Netherlands	....	475	....	....	....	95

a Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. *b* Not separately stated. *c* Annual average, 1889–1891.

Value of merchandise imported by certain countries in their trade with the Philippine Islands during the years (a) 1892 to 1896, inclusive.

Countries from which imported.	1892.	1893.	1894.	1895.	1896.	Annual average, 1892–1896.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United Kingdom	10,370,098	10,607,491	7,948,085	7,816,918	7,477,538	8,844,026
United States	9,159,857	7,008,342	4,731,366	4,982,857	4,383,740	6,053,232
Spain	4,421,846	3,391,759	3,196,778	3,953,059	4,312,383	3,855,165
Canada	2,204,368	1,135,402	423,417	864,711	1,242,441	1,174,068
France	395,624	558,985	882,434	1,291,048	1,801,969	986,012
Japan	323,084	345,384	840,915	622,580	951,190	616,631
Straits Settlements	370,816	320,044	(*b*)	(*b*)	(*b*)	*c* 345,430
Germany	220,150	227,290	127,330	205,632	225,386	201,158
Australasia	127,497	81,221	87,051	103,928	133,312	106,602
Netherlands	....	193,436	157,262	181,484	71	106,451
Dutch East Indies	(*b*)	(*b*)	(*b*)	(*b*)	99,174	*d* 99,174
China	45,344	24,188	62,260	12,990	13,770	31,710
Belgium	11,637	23,271	20,500	60,611	21,418	27,487
Austria	68,059	1,582	24,092	267	471	18,894
Ceylon	(*b*)	9,110	6,548	5,970	14,840	*e* 9,117
British India	10,145	6,096	7,017	7,727	8,188	7,835
Cape Colony	....	....	24	594	1,314	386

a Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. *b* No statistics available. *c* Annual average, 1892–93. *d* Statistics for 1896 only. *e* Annual average, 1893–1896.

IMPORTS INTO THE PHILIPPINES.

The following tables show the value of merchandise exported to the islands by the several foreign countries during each of the ten years

1887 to 1896, with the annual average for the first and second halves of that decade:

Value of merchandise exported by certain countries in their trade with the Philippine Islands during the years (a) 1887 to 1891, inclusive.

Countries to which exported.	1887.	1888.	1889.	1890.	1891.	Annual average, 1887-1891.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
United Kingdom	3,371,073	5,945,048	7,749,337	5,017,790	3,951,783	5,207,006
Spain	865,673	1,193,890	1,655,466	1,765,205	2,709,787	1,638,004
Germany	(b)	(b)	1,117,410	828,478	716,142	[c]887,343
Straits Settlements	987,428	719,540	706,948	592,672	549,842	711,286
France	269,130	253,661	500,201	428,107	259,558	342,131
China	336,397	351,645	381,093	275,457	274,571	323,833
United States	165,903	179,647	122,276	124,572	60,914	130,662
Australasia	104,172	92,288	136,506	80,881	146,924	112,154
Belgium	61,435	100,013	181,214	124,446	73,473	108,116
Japan	4,582	51,094	17,225	160,955	90,562	64,884
British India	5	2,417	14,228	113,949	168,374	59,795
Austria	(b)	(b)	39,360	34,157	35,471	[c]36,329
Netherlands	....	1,592	1,171	1,307	8,164	2,447
Canada	....	....	....	640	249	178

[a] Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. [b] Not separately stated. [c] Annual average, 1889-1891.

Value of merchandise exported by certain countries in their trade with the Philippine Islands during the years (a) 1892 to 1896, inclusive.

Countries to which exported.	1892.	1893.	1894.	1895.	1896.	Annual average, 1892-1896.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
Spain	3,644,976	4,377,214	5,512,943	4,933,445	7,401,433	5,174,002
United Kingdom	3,716,702	3,791,290	3,286,158	2,158,974	2,576,758	3,105,976
Germany	683,060	886,074	662,354	764,456	744,940	748,177
Straits Settlements	465,269	370,976	(b)	(b)	(b)	[c]418,123
France	215,434	222,510	249,577	181,852	163,898	206,654
China	166,765	165,399	154,751	125,752	103,031	143,140
United States	154,378	145,466	119,255	162,446	94,597	135,228
Australasia	122,159	85,962	169,758	92,794	127,980	119,731
Belgium	86,456	115,526	65,818	55,048	219,868	108,543
Japan	65,641	73,334	109,191	99,364	98,963	89,299
British India	69,682	55,098	66,271	80,106	70,268	68,285
Austria	50,912	64,772	92,067	59,568	50,836	63,631
Netherlands	4,148	8,627	20,190	8,912	14,303	11,236
Dutch East Indies	(b)	(b)	(b)	(b)	5,627	[d]5,627
Hungary	(e)	4,423	1,438	608	....	[f]1,617
Ceylon	(b)	32	193	147	82	[f]114
Canada	86	175	....	....	....	52

[a] Calendar years, except for the United States, Canada, and British India. For the United States and Canada, fiscal years beginning July 1 of the years specified. For British India, fiscal years beginning April 1 of the years specified. [b] No statistics available. [c] Annual average, 1892-93. [d] Statistics for 1896 only. [e] Not separately stated. [f] Annual average, 1893-1896.

The percentages of trade of some of the more important countries, as indicated by the figures of 1881 and those of 1893, are as follows:

Countries.	Per cent of total trade, 1881.	Import and export, 1893.
	Per cent.	*Per cent.*
British possessions in Asia	34.70	....
United Kingdom	33.72	37.32
United States	22.27	10.38
Spain	5.8	18.45
China	1.38	18.66
Germany	1.20	3.32
French Indo-China	....	1.38

The tables heretofore given make it possible to form some general ideas in regard to the trade and its apportionment among the countries with which the islands deal. There are some striking features about it.

TRADE WITH THE UNITED KINGDOM.

For the last thirty years or more the trade of the United Kingdom with the Philippines has ranked first in importance, amounting, as a general rule, to something more than one-third of the total trade of the islands. In this statement is not included the trade between the islands and the British Asiatic possessions of Hongkong, Singapore, and the Straits Settlements. The trade with these latter places is ordinarily scheduled as Chinese and Singapore trade. It is unquestionable, however, that a very large part of the trade credited to those ports is trade which may properly be classed under British trade, Singapore and Hongkong being ports of large transshipment. Were the trade of these ports included in that of the United Kingdom, and all entitled British trade, it is probable that at least one-half of the trade of the islands, export and import combined, would be scheduled as British trade.

The United Kingdom and, in addition, Hongkong and Singapore for years past have been steady exporters from the islands of some of their chief products. To pay for the products thus taken the United Kingdom has returned goods of British manufacture. As a rule, the manufactured products so returned have nearly, though never quite, balanced in value the amount of products taken from the islands. In spite of the amount of commodities sent by Great Britain, there has always been a balance of trade against her, varying in amount. In fact, Great Britain, the United States, and China, including Hongkong and Singapore, are the only countries dealing with the islands which have always had a balance of trade against them. Other countries have enjoyed a balance in their favor.

In recent years it would appear that the balance against England has tended to increase rather than diminish. This is doubtless owing to the increased introduction of the manufactured products of other countries, to wit, Spain, Germany, and France, supplanting in part the introduction of imports from the United Kingdom. In 1881 the United Kingdom sent to the islands merchandise worth something over $5,000,000 and took away products worth something over $8,000,000, enjoying a total trade slightly over one-third the total foreign trade of the islands. In 1892 she sent to the islands merchandise of about $5,000,000 in value and took away products of about $6,000,000 in value, still enjoying about one-third of the total trade. In 1893 she sent $4,000,000 and took away nearly $10,000,000, enjoying 37 per cent of the trade.

In the decade just referred to it is seen that while the amount taken from the islands by the United Kingdom has very greatly increased, the amount sent to the islands has very sensibly diminished. During the same period the imports into the islands from Spain, Germany, and France, and particularly the two first mentioned, very greatly increased. Although, as is seen, the value of goods sent to the islands by the United Kingdom has in recent years greatly decreased, the value of the products taken from the islands has so increased as to keep the percentage of the total trade of the islands which the United Kingdom has enjoyed about constant, to wit, in the neighborhood of 35 per cent.

TRADE WITH THE UNITED STATES.

For a long time the trade of the United States with the islands enjoyed a place second only to that of the United Kingdom, Hongkong, and Singapore. In 1881 it amounted to about 22 per cent of the entire trade of the islands. This percentage, large in comparison with that of other countries, save the United Kingdom, was due, however, not to a reciprocal trade, but to the large consumption by the United States of certain of the leading products of the archipelago. Indeed, the disparity between the value of products taken from the islands by the United States and the value of merchandise returned has been very great, much greater than in the case of any other country.

In 1881 the United States sent to the islands but little more than three-quarters of a million dollars of merchandise, while it took away from the islands nearly eight and one-quarter millions. In later years—1893, for example—its imports into the islands reached nearly one million, it taking away from the islands products of about three millions. Its trade with the islands has always resulted in a large balance against it. While the ratio of the United Kingdom's exports from the islands to her imports into the islands has been as 37 to 33, that of the United States has been as 15 to 3. Most of the other countries dealing with the islands have always been creditors—that is, with balances of trade in their favor.

The changes in the trade of Spain and Germany are very deserving of notice.

TRADE WITH SPAIN.

So far as information has been gathered, the trade with Spain prior to the last fifteen years, while next to that of the United States, was, nevertheless, far below it in amount. It ranged from 4 to 6 per cent of the total trade of the islands. In 1881 she had 5.8 per cent. This was made up of $1,365,000 of commodities sent to the islands, and of $973,000 worth of commodities taken away.

During the decade immediately succeeding 1881, and owing largely, as heretofore mentioned, to the commercial and industrial measures taken by Spain in behalf of the mother peninsula, her trade with the archipelago was very greatly increased; so that in 1893 she sent to the islands $5,104,000 worth of products and took away $1,919,000. In 1894 she sent $5,255,000 worth and took away $1,427,000, thus increasing her total trade between 1881 and 1893 more than 200 per cent, making it amount in the latter year to 18.45 per cent of the total trade of the islands, and taking second place to that of the United Kingdom. She became, not like the United Kingdom and the United States, a large debtor to the islands, but, on the contrary, their largest single creditor.

TRADE WITH GERMANY.

The German trade with the islands during the period under consideration was likewise greatly increased. In 1881 she sent to the islands $485,000 worth of merchandise and took away little or nothing, enjoying a total trade of but a very little over 1 per cent of the entire island trade. In 1893 she sent to the islands merchandise of the value of $1,246,000, exceeding that of the United States by about $300,000, and took away in value $19,728, or about one one hundred and fiftieth part of that taken away by the United States.

An approximate statement of the average relative percentages of import and export trade enjoyed by the principal countries dealing with the islands for the ten years prior to the insurrection of 1897 is set forth in the following schedule:

Approximate average relative percentages of exports from and imports into the archipelago in trade with principal countries.

Country.	Imports into the archipelago.	Exports from the archipelago.
	Per cent.	*Per cent.*
United Kingdom	33	37
China, including British Asiatic possessions	30	25
Spain	20	7
United States	3	15

In addition to the influence of the legislation of Spain heretofore referred to over the trade of the islands, the various trade relations of the several countries are in large measure explained by a consideration of the nature of the products of the islands and the demand for them by the countries dealing with the archipelago. The large trade of the United Kingdom and the United States and the large balances against them are due in great measure to the demand of those countries for hemp and sugar, and especially hemp. In their shipping and commerce these countries require great quantities of hemp, other countries taking comparatively little. Their demand for years has been more or less constant. England has been able to pay for the hemp and commodities taken by her by returning finished products. The United States has been able to pay her bill only to a limited degree in products, the balance being paid in money or exchange on other foreign countries. Spain, on the other hand, because of the remedial legislation referred to, ultimately became a great creditor of the islands, sending to them her products of cotton—the output of Barcelona and other factories—wines and spirits, oils, fruits, canned goods, etc. In return she satisfied her balance in part by products from the islands and in part by money. Of the products taken, the chief has been leaf tobacco, the next in importance being sugar and coffee.

In view of the great importance in the islands of four or five of its chief products, a word in regard to each of them may be serviceable.

HEMP.

Manila hemp is the product of a variety of the banana tree. It is a unique product of the archipelago and constitutes more than a third of the entire export trade. It is consumed almost wholly by the United Kingdom and the United States. In 1893 the former took about one-half and the latter about one-third of the entire amount, or together they took about 85 per cent. The average annual value of this export from 1886 to 1890 was something over $7,500,000, the average annual value of all exports during that period being nearly $19,000,000.

SUGAR.

The export of sugar is sometimes greater and sometimes less in value than that of hemp. Its average value from 1886 to 1890 was $6,740,000, being somewhat less than that of hemp. In 1893 it was some $3,000,000 more than that of hemp. As in the case of hemp, so also in the case of sugar, the United Kingdom and the United States are the chief consumers. Of the $10,000,000 worth of sugar exported in 1893 the United Kingdom took nearly $6,000,000 worth; China, Hongkong, Singapore, and Port Said some $3,500,000 more. The United States in this year (1893) took less than a half million. In the year previous it took nearly a million and a half.

TOBACCO

For a long period of years tobacco has formed another of the chief exports of the islands, constituting about 10 per cent thereof. It is exported in leaf and manufactured. More than half of the leaf export has gone to Spain. The export of manufactured tobacco is distributed throughout Europe and Asia. A merely nominal quantity has come to the United States. For a long period of years Spain's taking all the Philippine tobacco kept a fair balance with the archipelago's importation of products from Spain. In the latter years of Spanish dominion, as has been heretofore pointed out, Spanish imports into the islands were greatly in excess of her exports.

COFFEE.

During the decade 1880 to 1890 the coffee industry, though very newly introduced into the islands, made rapid strides and reached in its importance in the islands' export trade third or fourth place. It was cultivated in only a limited area, but its production bid fair to rival that of hemp and sugar as a permanent product of the islands. It was exported to the diverse coffee-consuming countries. In the last ten years, however, and with remarkable suddenness, its yield has been almost wholly cut off, owing to the destruction of the plants by a devouring insect. If preventive measures can be had against such ravages, it is reasonable to expect that coffee would again form a most valuable product.

COPRA.

Another of the leading exports of the islands is copra (dried cocoanuts). It has had an export in some years of a value of from $2,000,000 to $3,000,000. About 15 per cent of it goes to the United Kingdom and the balance to the Continent. A very small amount goes to the United States.

These articles mentioned—hemp, sugar, tobacco, and copra—form over 90 per cent of the entire export trade of the islands. A fair idea of the list of exports of the islands will be gained from the following table, giving a list, with the value thereof, in the year 1888:

Value of principal articles exported from the Philippine Islands during the calendar year 1888.

Articles exported.	Value.	Articles exported.	Value.
Manila hemp	$8,100,898	Fruits	$788
Sugar	6,271,030	Mother-of-pearl	7,230
Coffee	1,500,426	Tortoise shell	3,982
Leaf tobacco	1,340,311	Hide cuttings	6,229
Cigars and cigarettes	1,108,911	Old copper	5,182
Cocoanuts	130,609	Horns	7,545
Hides	139,618	Old iron	1,210
Sapan wood	88,102	Sesame	4,486
Indigo	94,810	Bones	3,590
Cordage	22,012	Cane	15
Gold, including gold jewelry	40,310	Flowering plants	1,088
Cocoanut oil	21,801	Glue	1,559
Hats	42,062	Edible birds' nests	1,476
Ylang-ylang oil	16,443	Sharks' fins	691
Tintarron *a*	16,841	Cigar cases	492
Timber	28,541	Wax	1,674
Candle nuts	2,173	Betel nuts	759
Trepang	18,094	Reexported articles	81,194
Candle-nut oil	20,868	All other articles	3,376
Copal	17,471		
Aloe fiber (maguey)	16,022	Total	19,169,922

a Liquid indigo.

IMPORTS.

The imports into the islands are conditioned, as in every other country, upon the needs and demands of the people. The manufacturing industries of the islands are very meager, and consist mostly of the crude manufacture of native products. Most manufactured articles have to be imported. In addition to imported manufactures, there is also the importation of foreign agricultural products, such as rice, wheat flour, canned goods, wines, meats, etc.

Of the importation of agricultural products, rice heads the list in value of importation. The islands are themselves a large rice-producing tract. In some years they have been able to supply their own demand and even at times to export. In later years, however, their supply has not met their demand, and rice has been imported in considerable quantities.

Wheat flour is also a staple import, and there is a steady increase in its consumption. Wines are an important article of import.

The following table shows the annual average value of the importation of some of the chief imports for the period of five years from 1886 to 1890, inclusive:

Value of principal articles of merchandise (agricultural products) imported into the Philippine Islands during each calendar year from 1886 to 1890, inclusive.

Articles imported.	Annual average, 1886-1890.	Articles imported.	Annual average, 1886-1890.
Rice	$1,836,000	Cocoa and chocolate	$46,812
Wheat flour	515,521	Macaroni, vermicelli, etc	46,186
Wines	496,149	Tea	38,641
Distilled spirituous liquors	251,323	Butter and lard	24,436
Canned goods	239,239	Cheese	19,856
Vegetables, including dried pulse	218,157	Flour, other than wheat	8,640
Beer and cider	102,313	Animals, live	*a* 8,140
Meat, pickled or salted; sausages, etc	99,746	Starch	*a* 4,081
Fruits	62,919		
Beeswax, stearin, etc	53,569	Total annual average value	4,069,284

a Annual average, 1886-1889.

As will be seen, the total annual average import of agricultural products amounts to about $4,000,000. Of nonagricultural imports the total in value is much greater, amounting for the same period of 1886–1890 to $11,284,576. Chief among these articles of import are cotton manufactures, iron and steel, mineral oil (kerosene), paper, and manufactures thereof.

The amount of importation of some of the principal articles will be seen from the following table, which gives the annual average value of importation for the period of four and five years from 1886 to 1889 in some cases and from 1886 to 1890 in others. This table is made up from one of the tables contained in Bulletin No. 14 of the United States Department of Agriculture, Section of Foreign Markets, entitled "Trade of the Philippine Islands," which gives very full statistics, and is an admirable presentation in detailed form of the trade of the islands:

Average value of principal articles of merchandise imported into the Archipelago between 1886 and 1890, inclusive.

Articles imported.	Annual average.	Articles imported.	Annual average.
Cotton manufactures	$5,778,675	Jute, flax, etc	$356,224
Iron and steel, and manufactures thereof	593,149	Umbrellas and parasols	192,179
Mineral oil (kerosene)	474,971	Wool and hair manufactures	176,781
Drugs and chemicals	452,595	Sundries (including earthenware, chinaware, glass, coal, matches, engines, jewelry, and a variety of imports not heretofore mentioned)	11,107,795
Paper, and manufactures thereof	401,210		
Silk manufactures	395,077		
Hats and caps	383,143		
Furniture	360,826	Total annual average value	11,284,576

The following are tables of Philippine trade for the year 1895, being, it is believed, the last year under Spanish dominion for which accurate data have thus far been obtainable. The first table also shows the customs duties collected by the Spanish Government in that year.

IMPORTS IN 1895.

Ports.	Value of merchandise.		Duties collected.	
	Pesos.	Dollars.	Pesos.	Dollars.
Manila	23,374,053	11,687,026	2,926,806	1,463,403
Iloilo	1,992,234	996,117	302,511	151,255
Cebu	31,061	15,530	1,832	916
Zamboanga	1,450	725	292	146
Total	25,398,799	12,699,399	3,231,441	1,615,720

EXPORTS IN 1895.

Manila	28,399,036	14,199,518	614,241	307,120
Iloilo	5,791,888	2,897,444	55,351	27,675
Cebu	2,461,803	1,230,901	59,771	29,885
Total	36,655,727	18,327,863	729,369	364,684

Principal articles of importation in 1895.

Articles.	Quantity.	Value, United States money.*a*
Mineral oils, chiefly kerosene ... kilograms	13,582,165	$1,193,503
Brandies and liquors ... liters	173,663	118,050
Rice ... kilograms	11,668,079	218,289
Coal and coke ... do	94,267,304	117,833
Beer and cider ... liters	384,901	65,183
Canned goods, preserves, and sweets ... kilograms	701,430	350,715
Matches ... do	714,515	178,630
Wheat flour ... do	8,080,550	436,340
Iron and steel ... do	6,559,979	481,394
Cotton threads ... do	901,761	750,976
Silk threads ... do	24,719	185,317
Garden vegetables ... do	2,677,312	133,865
Earthenware ... do	988,662	132,430
Paper ... do	1,836,032	357,658
Umbrellas ... number	200,510	99,303
Chemical and pharmaceutical products	....	194,310
Hats ... number	266,477	227,944
Textiles:		
Of cotton ... kilograms	4,290,021	3,778,631
Of hemp and flax ... do	134,614	123,457
Of wool and hair ... do	59,785	109,049
Of silk ... do	43,100	351,520
Glass and crystal ... do	1,889,058	102,670
Wines ... liters	2,701,634	810,489
Total	....	10,517,523

a These values are calculated from the Philippine peso at the rate of 2 pesos to $1.

PRINCIPAL PRODUCTS IMPORTED FROM SPAIN DURING THE YEAR 1895, IN QUANTITIES AND VALUES.

Brandies, wines, etc ... liters	70,818	$36,090
Canned goods and preserves ... kilograms	440,580	220,290
Macaroni, vermicelli, etc ... do	64,057	7,233
Garden truck and vegetables ... do	419,112	20,955
Cordage of hemp ... do	34,685	3,607
Printed books ... do	36,310	9,038
Playing cards ... do	56,106	30,858
Paper ... do	772,039	166,028
Textiles:		
Of cotton ... do	1,783,567	1,609,779
Of linen and hemp ... do	31,692	31,619
Of wool and hair ... do	14,271	22,636
Of silk ... do	15,117	140,811
Wines ... liters	2,673,344	802,004
Total	....	3,100,951

Importations, by countries, in values, during the year 1895.

Countries.	Value of importations.*a*	Countries.	Value of importations.*a*
Spain	$4,647,003	Austria-Hungary	$60,703
England	2,753,299	Holland	36,993
China, Hongkong and Amoy	2,125,811	Italy	8,991
Germany	984,151	Holland possessions	4,055
United States	516,930	British India	2,217
Switzerland	498,121	Denmark	1,970
Russia	273,750	Egypt	1,093
France	271,225	Spanish Antilles	750
Singapore	170,241	Norway and Sweden	307
Saigon	134,487	Portugal	112
Belgium	72,764		
Japan	67,906	Total	12,699,399
Australia	66,461		

a Values are calculated at the ratio of 2 pesos to $1.

Principal articles exported from the Archipelago in 1895 according to country of destination.

Article and destination.	Quantity.	Value. *a*
Hemp, in bulk:	*Kilos.*	
England	54,366,048	$2,007,892
United States	30,684,304	2,084,272
China *b*	20,175,050	2,104,539
Japan	1,059,116	82,840
France	541,300	30,975
Spain	318,849	19,674
Singapore	136,142	8,550
Australia	49,600	4,000
Egypt (Port Said)	3,542	1,771
	107,333,951	6,345,114
Sugar:		
England	145,859,095	2,320,893
United States	91,587,961	1,036,615
China *b*	66,613,242	1,720,534
Japan	16,538,397	344,166
Australia	10,807,160	234,408
Egypt (Port Said)	6,966,301	126,500
Spain	3,097,400	121,228
	341,469,558	5,904,344
Coffee:		
Spain	154,725	5,226
China *b*	16,250	6,133
Singapore	1,221	716
	173,270	118,490
Colored woods:		
China *b*	1,237,408	9,703
England	383,573	3,750
	1,620,981	13,453
Tobacco, manufactured:		
Singapore	438,037	313,095
China *b*	463,534	531,348
Spain	219,314	153,404
England	122,836	80,958
Egypt (Port Said)	40,920	31,278
Japan	23,635	13,222
Australia	5,925	3,440
Holland possessions	4,429	2.632
France	3,706	3,408
British India	125	85
United States	38	10
	1,321,869	1,132,882
Tobacco, in leaf:		
Spain	6,974,954	720,541
Egypt (Port Said)	2,354,764	262,341
Singapore	376,072	60,225
China *b*	263,511	30,789
England	90,121	7,748
	10,059,422	1,081,646

a Values are calculated at the ratio of 2 pesos to $1.
b Importations to the English port of Hongkong are presumably included with those of China.

The following is a schedule of the average customs duties, taxes, fines, etc., collected at the custom-houses of the Philippines for a period of five years—1890 to 1895:

Source.	Average annual amount, 1890 to 1895.	
	Pesos.	Dollars.
Importation	3,305,281	1,652,640
Exportation	340,057	170,028
Navigation tax	1,356	678
Confiscations and fines	16,448	8,224
Mercantile deposits	320	160
Tax on merchandise consumed in voyage	47,589	23,794
Loading tax	325,925	162,962
Discharging tax	90,631	45,315
Fifty per cent additional tax	66,319	33,159
Various other taxes	12,519	6,259
Total	4,186,458	2,093,229

Little or nothing has been obtainable of the commerce in 1896, except that in that year Spain's imports into the Philippines amounted to 8,261,911 pesos, or about $2,130,000, and her exports in that year to 4,595,345 pesos, or about $2,297,000.

In 1897 the imports from Spain were 1,583,415 pesos, or $791,707, being greatly augmented on account of the importation of money, included in the amount stated, and on account of the extraordinary importation of commodities required by the additional troops then maintained in the islands owing to the insurrection. The total value of the importations into the islands in 1897 is said to have amounted to the sum of between 22,000,000 and 24,000,000 pesos—to wit, $11,000,000 or $12,000,000—and the total exports to some 28,000,000 pesos, or $14,000,000.

Shipping and clearances of vessels from ports of the Archipelago in 1894.

ENTRANCE.

Ports.	Number.	Tonnage.
Manila	248	305,468
Iloilo	67	75,305
Cebu	15	16,562
Total	330	397,335

Of the above 330 vessels, 62, with a tonnage of 73,000, were under the Spanish flag; the balance were under foreign flags.

CLEARANCE.

Ports.	Number.	Tonnage.
Manila	221	275,142
Iloilo	38	64,145
Cebu	12	18,946
Total	271	358,233

Of the above number, 42, with a tonnage of 54,622, were under the Spanish flag; the balance were under foreign flags.

Of the internal trade of the islands few statistics are available. Such as have been obtained, though very deficient, indicate an export trade from Luzon, the Visayas, and Mindanao to other parts of the archipelago of some 10,000,000 pesos, or $5,000,000, in recent years.

PAPER NO. XVII.

MEANS OF COMMUNICATION.

MEANS OF COMMUNICATION.

As elsewhere stated in this report, the Philippine Archipelago embraces a great number of islands, large and small, estimated at about 1,700. It is manifest, therefore, that water must be the great highway of communication in the archipelago, as well as between the archipelago and foreign countries. In the time of Spanish dominion there existed well-established lines of foreign communication as well as of interisland communication. The chief single means of communication between the archipelago and Europe was that of the Compania Trans-Atlantique, a Spanish line of steamships subventioned by the Spanish Government, plying between Manila, Barcelona, and intervening ports, and carrying the regular mails. One of these ships left Barcelona and another Manila at least once in every four weeks. Additional trips were also made from time to time. Other facilities for communication between the archipelago and Europe were by means of various lines of steamers plying between the Far East, the Straits Settlements, India, Suez, and Europe, such as the Messagerie Line, the Peninsula and Oriental Line, and the Japanese Line.

The islands are also in direct and constant communication with Hongkong, Amoy, Saigon, and Singapore, across the China Sea, by means of steamships of smaller tonnage plying between the archipelago and those ports. At Hongkong connections are made with the lines for Europe and with the great trans-Pacific lines for San Francisco and Vancouver by way of Japan. In addition steamships of fairly good size call at archipelagic ports on their way from north China and Japanese ports to Australian ports.

Since the cession of the archipelago to America the means of communication with foreign ports have considerably increased, partly in the number of ships used on the old lines, and partly by the establishment of new lines. Owing to the increased interest of Americans in the archipelago and the Far East, the transit of passengers, freight, and mail across the Pacific has been greatly increased. This increase has been met in large measure by the regularly established lines plying between Vancouver, San Francisco, and Hongkong, and by the United States transport service, which has carried the troops and official freight and mails of the United States.

INTERISLAND COMMUNICATION.

The interisland communication has, of course, been seriously interrupted during the insurrection. It is reasonable to expect that when peace is restored throughout the archipelago it will resume its former importance and be greatly increased in magnitude. According to official figures, in 1891 there were some 7,000 registered craft of all kinds engaged in the interisland trade, and it is reported that in 1895 the number had increased to 11,000.

The bulky products of hemp, sugar, tobacco, and copra produced in various parts of the archipelago have always depended upon interisland craft for transport to Manila or other ports of the islands (Iloilo and Cebu) for transshipment to foreign parts. Of these vessels, some have belonged to established lines and others have run independently. Of the established lines the Spanish Government selected certain ones for the carrying of interisland mails. There were four such mail lines in number—(1) the mail line of North Luzon; (2) that of South Luzon; (3) that of southeast of the archipelago, and (4) that of south of the archipelago.

Line 1, that of North Luzon, starting at Manila, touched at the following among other points: Subig, Zual, San Fernando (Union), Caoayan, Currimao, Aparri, Calayan, Batanes, and Isbayat.

Line 2, that of South Luzon, starting from Manila, touched at the following among other ports: Batangas, Calapan, Boac, Laquimanoc, Pasacao, San Pascual, Palanoc, Donsol, Sorsogon, Legaspi, Virac ó Bato, and Tabaco.

Line 3, that of the southeast of the archipelago, starting from Manila, stopped at Romblon, Cebu, Orinoc, Catbalogan, Tacloban, Cabalian, Surigao, Camiguing, and Misamis.

Line 4, that of south of the archipelago, ran from Manila to Cottabato, stopping at Culion, Cuys, Puerto Princesa, Puerta Separacion, Marangas, Balabac, Cagayan de Jolo, Iolo, Isabela de Basilan, Zamboanga, and Tukuran.

RIVER AND HARBOR COMMUNICATION.

Numbers of small boats, carrying passengers and freight, ply the various harbors and rivers of the archipelago, some in established lines and others separately. The rivers of the archipelago afford the chief means of transportation for the heavy products of the islands from the interior to the seaboard. In most of the large islands of the archipelago there are rivers of large size running to the sea. In the island of Luzon the principal one is the great river of Cagayan, rising in the mountains in the middle of the island north of Manila and flowing north for a distance of over 200 miles, emptying into the sea at Aparri. It is navigable for a considerable portion of its length, depending, of course, upon the kind of craft. It is said that the ordinary river craft, for the transporting of merchandise, navigate it for some 75 or 80 miles from its mouth, beyond which point only small boats or dugouts can proced. The navigation is greatly impeded, however, by fallen timber, floating trees, etc., which come down in the wet season.

Among the other rivers of Luzon navigable in part may be mentioned the Agno, in the middle west, about 100 miles long; the Abra, also 100 miles long, and the Rio Grande de la Pampanga, an important navigable river running through the rice districts of Pampanga, Tarlac, and Neuva Ejica, and emptying into the bay of Manila. The short river Pasig, some 20 miles in length, is important in the trade of Manila, connecting the Bay of Manila with the great Lake of Laguna de Bay, and forming a means of water communication with the territory lying around that lake.

In the island of Mindora there are about seventy known rivers, of which some ten or a dozen are of importance. The Visayan Islands also have a due proportion, and the island of Mindanao has, among other large rivers, the river Agusan, which crosses nearly the entire island and has a length of about 225 miles. Most of these rivers are in their more or less natural state, little attempt having been made to improve their navigation.

LAND COMMUNICATION.

The islands are exceedingly deficient in proper means of land communication. There is need of railways, highways, byways; the repairing of old and construction of new. The need of railways is especially felt in the great island of Luzon. It was felt under Spanish dominion, and considerable study was given to the matter from 1875 down to the termination of Spanish rule. One road of 122 miles was constructed. In the year mentioned the preparation of a railway system for the islands was authorized and a commission appointed. A general plan of railway system was elaborated in 1876. It was not, however, until 1884 that any practical result came of it. In that year construction of the railroad from Manila to Dagupan was authorized. Some difficulty was experienced in the undertaking. At first there was an attempt to dispose of the franchise at public auction by an offer of subvention on the part of the state of a specific sum per kilometer. This did not prove acceptable, and finally the method of subvention was changed to that of a guarantee of 8 per cent upon the capital invested. By a decree dated April 9, 1887, a concession was made on those terms, the Government of Spain guaranteeing an interest of 8 per cent upon the estimated cost of 4,914,473.65 pesos.

The franchise was taken by an English company, entitled "The Manila Railway Company, Limited." The construction of the road was begun in 1888, and, with the exception of the Rio Grande bridge, was finished in 1892. The road runs northwest from Manila to Dagupan, traversing the provinces of Manila, Bulacan, Pampanga, and Pangasinan. It is 122 miles long. The capital of the company is £1,700,000. The commission has no information as to the exact cost of the road. It was testified, however, that the cost was greatly in excess of the amount that it should have cost; that in many cases the requirements of the Government were excessive and unnecessary, and that under the American system of railroad building a proper railway of that length could be built to-day for a much smaller sum.

The road traverses one of the most fertile and populous districts of the island and has had a great effect upon the wealth and condition of the territory through which it runs. It is said to have increased the amount of products of the territory through which it passes more than 100 per cent. It passes through rice and sugar lands. The natives are very fond of travel and make large use of the road.

In addition to this road, which reached completion, other roads were contemplated by Spanish authorities. Some of them progressed as far as survey and specific study. Of various lines proposed, the following are conceded to be the more necessary: A line either starting from Manila independently, or leaving the Manila-Dagupan Railway at Quinqua; thence running north through the great rice plains of the Rio Grande, traversing the watershed between the Rio Grande and the Cagayan River, passing through the rich tobacco lands of the province of Isabela and down the fertile lands of the province of Cagayan to the town of Tuguegarao, from which place the Cagayan River is navigable to its mouth. This line would bring Manila into communication with the great northeastern portion of the island of Luzon and afford an outlet for the products of the northern provinces. The existence of this railway would, it is said, open up an immense tract of fertile land to greatly increased production.

Another line of equal, if not greater, importance, and one for which a more or less thorough study has been made by Spanish officials, should run from Manila south to the town of Taal, on the southern coast, a distance of 100 miles, passing through a very populous and rich agricultural district and touching many of the other interior towns. This road could be continued when found expedient through the lower provinces of the island of Luzon, Tayabas, and Camarines, to Albay, thus affording a complete system of railroads from the north to the south of the island, and placing the capital of the archipelago in more or less direct and speedy communication with its principal provinces. From time to time branches of these roads could be built as might be found expedient.

Other roads in the islands of Panay, Negros, and Cebu are suggested. It does not appear, however, that there is the same pressing need for them.

HIGHWAYS.

As in the case of railroads, so even more in the case of highways, there is a sad deficiency and need. In the island of Luzon there are laid down on the maps three large highways, with byways leading from them. They are, first, a road running northwest from Manila and extending up through the provinces of Manila, Pampanga, Tarlac, Pangasinan, Union, Ilocos Sur, and Ilicos Norte to the town Laoag, a distance in all of some 340 miles; second, a high road starting from Manila and running northeast through the provinces of Pampanga, Nueva Ejica, Nueva Viscaya, Isabela, and Cagayan to Aparri, a distance of some 355 miles; third, a highway of the south running from Manila, through the provinces of Cavite, Laguna, Tayabas, and the Camarines, to Albay, a distance of some 300 miles.

These highways are said to be fit for carriages in the dry season; and, with exceptions, they are likewise said to be in a very wretched state of repair and preservation, being in parts and for whole sections next to impassable. In the rainy season communication by means of them is almost wholly suspended, not only on account of clay, mud, and washouts, but also on account of the lack of bridges. These four highways in the island of Luzon furnish a basis, however, for the construction of a proper system of highway communication in the island. They need to be repaired; bridges need to be built, and when once repaired they need to be so maintained. The highways in the other islands are said to be, as a rule, in far worse condition than those of Luzon.

BYWAYS.

With regard to the smaller roads leading from the highways, it need only be said that they are few and far between and, as a rule, in wretched condition.

The whole road system of the islands needs careful attention and vigorous reformation. Upon it depends in large measure the prosperity and welfare of the people.

TELEGRAPHS AND CABLES.

The archipelago is connected with the Asiatic continent, Europe, and America by a cable running from Manila to Hongkong. From Hongkong the messages are transmitted by some one of the cable lines running across the continent of Asia or touching from point to point along the Indian Ocean, Mediterranean Sea, etc. To reach San Francisco a cable message from Manila traverses from longitude 120° east to longitude 122° west, or in all 242 out of the 360 degrees, with a corresponding cost per word of telegram. The business done over the Manila-Hongkong cable since the cession of the islands by Spain to the United States has been of large proportions.

Telegraphic communication between the islands has been planned by the United States authorities on an adequate scale and several new cables have been run. Manila is now connected with Iloilo, Cebu, and other points in the Visayan Islands.

TELEGRAPHS.

The first telegraph line of the archipelago was erected in 1872 and ran from Manila to Cavite. There are now, or were before the insurrection, three principal lines in Luzon, with numerous branches; one in the northwest, following, as a rule, the highway of the northwest to Laoag, in the province of Ilocos Norte; one in the east, following the highway of the northeast and terminating in Aparri, in the province of Cagayan, and one in the south, running from Manila to Sorsogon, in the province of Albay. In the other islands telegraph facilities also existed. Much of the system has doubtless been destroyed or has greatly suffered during the insurrection. It is a means of communication, however, that can be restored and extended with comparative ease.

PAPER NO. XVIII.

FOREIGN POPULATION.

FOREIGN POPULATION.

It has been deemed advisable to furnish some description and to give a few statistics of the population and business of the important cities in the Philippine Islands.

MANILA.

Manila, the capital of the islands, is situated in the island of Luzon, at the mouth of the river Pasig, which flows into the bay of Manila. It was founded in 1571. Earthquakes, with very disastrous results, occurred in 1645, in 1863, and in 1880. To meet these conditions, as far as possible, the dwelling houses are usually of not more than two stories, and covered with corrugated iron. The old city of Manila is surrounded by a wall and a moat, and the larger Government buildings and many of the religious institutions are located therein. Across the river Pasig from the intramural city are the centers of trade and industry. On the Escolta, which is the main retail business street, are found most of the European stores and bazaars. This portion of the city is called Binondo. The Rosario is another broad thoroughfare, which is occupied chiefly by Chinese shops. San Miguel is an aristocratic suburb, as is also Malate.

The architecture of Manila is not imposing, owing to the often recurring earthquakes. The city has an old appearance. In the evening the streets are very animated; apparently all the world being out for a drive. There are several ancient churches. The church of San Sebastian is notable for having been constructed of iron and steel, which was brought ready to put up from Belgium. The cathedral, which was founded originally in 1578, has been several times destroyed by earthquakes. It suffered great damage in 1884. There are several theaters, but none of any particular note. There is an opera, which is well patronized. At various places in the city are statues; for instance, Charles IV and Isabella II. There are monuments to several distinguished Spaniards.

The ordinary population of the city is about 300,000. It is the seat of a large commerce, which is continually increasing. The principal articles of export are hemp, sugar, tobacco, cigars, coffee, and indigo, and the chief imports are cotton goods.

The anchorage for large ships is about 3 miles from the shore, but of smaller vessels there are a great number grouped in the mouth of the river, and steamboats drawing 7 feet of water go a little distance up the river to the bridge of Spain, which spans the Pasig, and are there loaded and unloaded; cascoes and tugs go underneath this bridge and farther up the river.

Before our occupation in 1898 there were six Spanish newspapers published in Manila. Some of these have been discontinued and others have taken their places, so that there are about that number published there now. There are several American newspapers, the three principal of which are the Manila Times, the American, and Freedom.

The hottest season of the year commences in March and continues throughout May. The temperature averages about 81½° F. It varies but slightly during the year. The climate may be said to be a continual summer. The rains commence in June and continue to December. Last July the rainfall amounted to 48 inches, but this was considered to be abnormal, the ordinary rainfall for this month being about 15 inches. The maximum annual rainfall is 114 inches, and the minimum 84 inches. The maximum temperature is about 92° and the minimum 61°.

The last census was taken in 1883. There were then residing in Manila 250 foreigners of European origin, 4,189 European Spaniards, 15,157 Chinese, 46,066 Chinese mestizos, or half-breeds, 3,849 Spanish mestizos, and 160,896 pure natives.

In 1897 our imports from the Philippines amounted to $4,383,740. Our exports to the Philippines were $94,597, but we have not been able to secure exact statistics for Manila.

In 1894 the principal exports from Manila were: Sugar, 105,019,245 kilograms; hemp, 82,108,599 kilograms; raw tobacco, 7,019,117 kilograms; manufactured tobacco, 1,144,365 kilograms; precious and dye woods, 2,405,755 kilograms; coffee, 603,156 kilograms.

There are tramways in the principal streets of the city, and there is a railway to Dagupan, 122 miles, which was opened on the 23d of November, 1892. There is also a steam road to Malabon. There are electric lights in the streets and public squares, and in many of the houses. There is a very good water supply, which is brought from the Mariquina River. The telephone system extends throughout the city, and as far as Malabon. There are many educational and charitable institutions, which have been enumerated in other parts of this report. There is a telegraph service from Manila to all civilized portions of Luzon Island. There is a land line from Manila to Bollinao, Zambales, from which point a submarine cable was laid in April, 1880, by the Eastern Extension Australasian and China Telegraph Company, Limited, whereby Manila was placed in direct telegraphic communication with the rest of the world. In May, 1898, Admiral Dewey ordered the Manila and Hongkong cable cut, but the connection was made good again on the 21st of August, 1898. In 1897 another submarine cable was laid by the above company, under contract with the Spanish Government, connecting Manila with the southern islands of Panay and Cebu (Tugaran). This cable was also cut on the 23d of May, 1898, but after the 12th of August was reopened.

The following countries had, under Spanish rule, consulates at Manila, the most of which are continued: Austria-Hungary, Brazil, Chile, Denmark, Ecuador, France, Germany, Great Britain, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Portugal, Russia, Sweden and Norway, Switzerland, and the United States.

The foreigners in the islands are engaged in all branches of business and professions. The English are principally engaged in banking and exporting the products of the islands, chief among which is hemp; they also are the greatest transportation agents, representing most of the shipping interests of the Philippines. The Germans, French, and Swiss are chiefly engaged in importing; while all the foreigners are occupied to some extent in sugar raising and refining. Many foreigners follow all the ordinary businesses of life, such as brokers, attorneys, physicians, and merchants.

In considering the future of the Philippines, naturally the rights, privileges, and obligations which have arisen with reference to the foreigners therein would have to be considered with some care. Article VIII of the treaty of December 10, 1898, by which the property of the Crown of Spain in the Philippine Archipelago was ceded to the United States, provides that such cession "can not in any respect impair the property or rights which by law belong to the peaceful possession of property of all kinds, of provinces, municipalities, public or private establishments, ecclesiastical or civic bodies, or any other associations having legal capacity to acquire and possess property in the aforesaid territories renounced or ceded, or of private individuals, of whatsoever nationality such individuals may be."

The terms of the treaty cited would have to be complied with by any government that might be established in the Philippines. Having assumed these obligations, we must see that they are complied with.

ILOILO.

This port is the chief town of the province of Panay. It is situated in latitude 10° 48′ north, near the southwestern extremity of the island, close to the sea. It is built on low, marshy ground, partly along the sea and partly along the left bank of a creek or inlet which runs toward Jaro, and after describing a semicircle, again meets the sea near Iloilo. It is the principal seaport and seat of government of the province, but it is smaller than some other towns in its vicinity. The harbor is well protected and the anchorage good. The depth of water on the bar at the entrance to the creek or river, Iloilo, is about 5 fathoms at low water. It decreases in a short distance to 15 feet, and then deepens again.

Iloilo is said to be a very healthy place, and is cooler than Manila. The better class of houses are built on strong wooden posts, 2 or 3 feet in diameter; these posts reach to the roof. They have stone walls to the first floor, with wooden windows above, and iron roofs. The poorer class of dwellings are flimsy structures of nipa, built on four strong posts. Means of communication with the interior are very inadequate.

The principal manufacture in Iloilo is that of pina, a cloth made from the fiber of the pineapple leaf. Another cloth called jusi is woven from silk, and is made in white and colors. The country around is very fertile. The annual crop of sugar is estimated at about a million of piculs. Tobacco and rice are largely cultivated. Typhoons do great damage. Earthquakes are rare.

Iloilo is about 250 miles from Manila. The chief article of export is sugar. In 1894 the imports were $2,225,690, and the exports in the same year were $4,624,290. In 1894 Iloilo exported 1,455,037 kilograms of valuable hard and dye woods. The island of Negros contributes three-fourths of the sugar shipped from Iloilo. The following countries have consulates in Iloilo: Germany, Great Britain, and Portugal. There are many foreign merchants here. The Hongkong and Shanghai Banking Corporation has a branch here, and the National Bank of China, the Chartered Bank of India, Australia, and China, the Bank of India, China, and the Spanish Filipino Bank are here represented.

When peace is restored Iloilo will become a prosperous city. Americans will be greatly attracted to it by the many varieties of fine wood that are found on the island of Panay and adjacent islands.

CEBU.

Cebu is the capital of the island of the same name, and ranks next to Iloilo among the ports of the Philippines. It is a well-built town and possesses fine roads, but there is little commercial enterprise among the people. The trade consists principally of hemp and sugar.

The neighboring islands of Leyte, Mindanao, and Cameguin possess extensive hemp plantations. This produce finds its way to Cebu for shipment.

There are some valuable and extensive coal deposits in the island, but the mines have not as yet been worked with any enterprise.

In 1894 the imports were $205,671, the exports amounting to $2,671,688. Sugar and hemp were the principal exports in 1894.

Germany, Great Britain, Denmark, Italy, and Venezuela have consulates at Cebu. These consulates are mostly in the hands of vice-consuls who carry on business. There are some other foreign merchants, and most of the larger houses in Manila have branches here.

The population of Cebu in 1896 was 10,972, against 9,629 in 1888. The inhabitants of the island of Cebu in 1896 amounted to 595,736. Cebu was the residence of the brigadier-governor of the Visayas, as well as the governor of the island, and the usual local officials. In 1886 the supreme court of Cebu was established.

PAPER NO. XIX.

PUBLIC LANDS OR DOMAIN.

PUBLIC LANDS OR DOMAIN.

It has been impossible to obtain accurate data or information with reference to the public lands and other public property belonging to the Spanish Government as sovereign in the archipelago. There existed under the Spanish administration a department known as the inspección de montes, which, among other duties, had general supervision and charge of the public lands (realengos). It pertained to this department to make surveys of land, run lines of demarcation, etc. For this purpose it had attached to it a corps of engineers. Outside of the general organization of this department little information in regard to it or its accomplishments was obtainable. The records of the department had recently gone through a fire and, up to the time of the leaving of the commission, were in charred and hopeless confusion. The commission was informed that, even if intact, these documents would probably give little or no information as to the extent of the public domain throughout the archipelago. From general information gathered from various sources, particularly from natives acquainted with the provinces, the opinion has been formed that the public domain in the archipelago is very large. Some place it as high as one-half the area of the archipelago.

For the most part these lands are in the more remote and inaccessible portions of the islands, being the mountains, the uplands, and other lands more or less remote from means of communication. It is said, for instance, that of the province of Union, which, with respect to mountains, uplands, and remote lands, may be taken as an average province, one-half is public domain. These lands are wild and wooded, in many cases with valuable growing timber standing upon them. The mines of coal, iron, copper, gold, and other mineral deposits, which by many are believed to abound in the islands, are in large measure, it is said, to be found upon this public domain. So far as has been learned the surveys of this land have been meager and very incomplete. When proper means of communication have been developed and proper measures adopted for taking advantage of the benefits of these lands they will doubtless form a large reserve source of revenue for the benefit of the government of the islands.

LAND TENURE AND HYPOTHECATION.

The privately owned lands in the archipelago are held for the most part by individuals or families and by the religious corporations. It has not been possible for the commission to ascertain accurately what land is held by the corporations. It is stated that their holdings are very large and of the most fertile and valuable lands of the islands.

There is great need, it is said, of a revision of the laws respecting the tenure and transfer of land. The present method of transfer is so cumbersome and the methods of recording and certifying titles so imperfect as to render transfers difficult and titles insecure. For this reason, it is said, the landowning class finds great difficulty in securing the capital which it so greatly needs. If a modern system of transfer and of mortgaging were adopted, rendering transactions easy and secure, capital could be had by landowners at a fair per cent, thus greatly encouraging the agricultural development of the country. Some of the most enlightened lawyers of the archipelago favor the adoption of the Torrens system of land transfer and mortgage, or a system based upon or similar to it. This system has been practically adopted in Australia with satisfactory results, and also in several of the States of the United States, and there seems to be much to recommend its adoption in the islands.

PAPER NO. XX.

RELIGION.

By The Jesuit Fathers.

RELIGION.[1]

PROPAGATION OF CATHOLICISM.

DIFFICULTY OF THE UNDERTAKING.

Among the benefits which the Filipino people have received from Spain, the greatest and transcendent has been the apostolic Roman Catholic religion, with the abolition of the idolatry and heathen superstitions which they formerly professed.

In order to understand what this benefit is and the difficulties which the missionaries had to encounter in the evangelization of the Philippines, it is necessary to look back and briefly consider what the Filipinos were before the Spanish conquest.

SUPERSTITIONS AND BARBAROUS CUSTOMS OF THE INDIANS.

What were the Filipinos before Magellan and Legaspi arrived at these islands as regards religion? They were what the immense majority of the idolatrous Indians of Asia, the Chinese, the Japanese, the Igorrotes, the Ataas, the Manobos, and the savages of the high mountain ranges of Mindanao, not yet conquered and converted to the Christian faith, are still to-day. They were Animists, or worshipers of the souls of their ancestors; they were Sabians, or worshipers of the sun, of the moon, and of the stars. They had no idea of one God, spiritual, infinite, eternal, Creator of heaven and earth, and Kind Father of the human race; they found gods in plants, in birds, in quadrupeds, in cliffs, in caves, and in the reefs of the sea. This explains how the Tagalos worshiped a blue bird called Tigmamanuquin, which they honored under the name of Bathala, which signifies among them divinity; they gave the same honors to the crow, which they called Maylupa, or lord of the earth; they did the same with the alligator, which they saluted when they saw it in the water by the name of Nono, which means grandfather, and affectionately begged it not to hurt them, and for this purpose they offered it something of what they had in their canoes.

Among the rocks which they adored and to which they offered gifts, one on the banks of the river Pasig, near Guadalupe, was for many years an idol of the Tagalo worship, which they said was a crocodile changed into stone. They adored, as all the people of the Malay race, the tree called Balete, and they did not dare to cut it. They had in their houses many monstrous small idols, which the Visayas called Dinata and the Tagalos Anito. According to them there were anitos of the country, who gave permission to go through it; anitos of the fields, who influenced the fertility of the earth; anitos of the sea, who fed the fishes and took care of boats; anitos to look after the houses and new-born and nursing infants. These domestic anitos were, according to the Malays, the souls of their ancestors, whom they venerated with a religious worship, as the Chinese do; and even some old people, in order to have themselves adored by the people after death, affected a divine air and demeanor in their words or actions.

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[1] This paper on Catholicism in the Philippine Islands is furnished by the Jesuit fathers of Manila.

They described the creation of the world with gross fables. They said that formerly the sky and water were walking together; that a Milano (kite) interfered between them, and in order to keep the waters from rising to the sky, he placed over them the islands, and so the world was formed, which for the Filipinos was represented by a number of islands. The first man and the first woman, according to the Filipinos, came out of a piece of bamboo. This cane was floating on the water; the water cast it at the foot of a kite, and he, angered by the blow, broke it open with his beak, and the man came out of one joint and the woman out of another.

They believed that the souls of the defunct were material; that they ate morisqueta and drank tuba, and so, on burying the dead, they placed food on their sepulchers. This custom is still kept up among the savage races of Mindanao.

Instead of priests they generally had priestesses, whom the Visayas called baylanas and the Tagalos catoolanas, who used to be ridiculous, astute, and devilish old women who, at the feasts, made sacrifices of animals, and even of slaves and human victims, to the sound of musical instruments. When a chief fell sick and found no relief in medicines, he called on the baylana or catoolana. She placed a pig or a bound slave near the bed of the sufferer, or in the middle of the room; then taking a lance and dancing to the sound of a bronze bell, called agum, she attacked the victim and wounded him with a lance thrust, and with his blood she anointed the sick person, and then opened the entrails of the animal or of the slave and examined them after the manner of augurers; and the baylana or catoolana, pretending by grimaces and foamings at the mouth that the prophetic genius had taken possession of her, predicted the result of the malady. If the prophecy was of life, all ate and drank until they became drunk; if it was of death, she consoled the sick person by telling him that he should prepare to ascend to the stars by way of the rainbow.

The Filipinos did not have churches, because all their houses served them as chapels or places of worship. They believed in a multitude of auguries or superstitions. The hooting of the owl and the song of the wild dove, called limocon; the sight of a serpent, the hissing of a lizard, were to them so many messages from heaven. The asuang was an evil sprite, witch, or demon, feared by all the Tagalos, Bicoles, Panpangas, Visayas, and Mandayas; and they believed that it took different forms, such as dog, cat, bird, goat, or other animal. The asuang caught, by preference, abandoned children, solitary travelers, and even with its horrible, swollen, black, and flexible tongue extracted unborn children from women. A thousand other fabulous and fictitious horrors were attributed to the asuang.

Finally, whoever wishes to inform himself of the superstitions and the dark myths of infidelity with which all the Malay race of the Philippines were surrounded on the arrival there of the Spanish Catholic missionaries should read Book 3, Chapters XVI and XVII, of the history written by Father Delgado of the Company of Jesus; or count, if

PLATE 1.

MISSIONARY TEACHING NATIVES (ZAMBOANGA).

he has time and takes pleasure in it, the nine hundred divinities or superstitious beliefs so ably described by the German Philippinologist, Fernando Blumentritt, in his recent Mythological Dictionary.

To this darkness in religion should be added the corruption of Philippine morals in the times of paganism, the buying and selling of wives which took place whenever matrimony was entered into; the usury or premium on loans to an inconceivable degree; slavery so general in the country that children had no objections to making slaves of their parents; war to the death, or to the extermination, of some tribes against others; and anyone will be convinced of the great labor and difficulties which presented themselves to the missionaries in propagating Catholicism with such happy results among the inhabitants of the 1,400 islands of which the archipelago of Magellan is composed, all of whom were in general imbued and saturated to their bones with those superstitions and customs so contrary to the Gospel and to Christian civilization and so difficult to uproot. Who could have caused the Philippine nation, buried in the darkness of their false deities, obscene rites, and bloody sacrifices to be transformed into a Catholic nation, zealously believing in one true God; most devoted to the immaculate Virgin Mary, preeminent in the services of the Catholic worship; acknowledging the sanctity of marriage; respectful to their wives, whose dignity has been raised to the height of a true companion for man; generous toward their slaves, to whom they gave liberty as soon as they embraced the Christian faith? This radical transformation of a people could only proceed from divine grace, and through the medium of the Catholic Church, the only true church of Christ, which has civilized Europe and America, and which will civilize the rest of Oceania, Africa, and Asia.

But let us see how this miracle was accomplished.

EXTENDED THROUGH THE ARCHIPELAGO BY THE AUGUSTINIAN, FRANCISCAN, JESUIT, DOMINICAN, AND RECOLETO MISSIONARIES.

We have already told how the first missionaries of the Order of St. Augustine, who arrived at the Philippines with the immortal Legaspi, labored for the conversion of the Indians. Father Herrera founded the province of the Santisimo Nombre de Jesus with Augustinian monks (not barefoot), returned to Europe, where he gathered together 40 missionaries of his order, of whom 34 were left in Mexico on account of illness, and the other 6, together with 3 others, residents of New Spain, undertook the journey to these islands, but were wrecked by a furious storm on the coast of Catanduanes, and there murdered by the savages. How many missionaries, martyrs like these, the history of the Philippines records. But that does not matter. The Order of St. Augustine grew, watered with the blood of its sons, and they founded their first convent in Cebu, and soon after another larger one as the head of the order in Manila. On the other side of the Pasig River the Augustinian missionaries founded the parish of Tondo, that of Tambobong, and that which bears the name of Pasig, near the Lake of Bay; and traveling through Bulacan they founded the convents and parishes of Dapdap, Guiguinto, Bigoa, Angat, Balinag, Quingua, Malolos, Paombong, Calumpit, and Hagonoy. In the province of Pampanga they founded a multitude of Christian communities, such as those of Bacolor, Macabebe, Porac, Mexico, Arayat, Tarlac, and they arrived as far as San Miguel de Mayumo, Candaba, Apalit, and even to the mountain ranges, where they domesticated the mountain Indians. In Batangas they founded towns as large as Taal, Balayan, Bauan, Batangas, Tanauan, and Lipa, which have 20,000, 30,000, and 40,000 inhabitants, all Christians. In the island of Panay they founded the parishes of Capiz, Dumalag, Antique, Jaro, and many others. Even in the provinces of Ilocos they established missions in the northern part of Luzon, which later, in the course of time, became large towns.

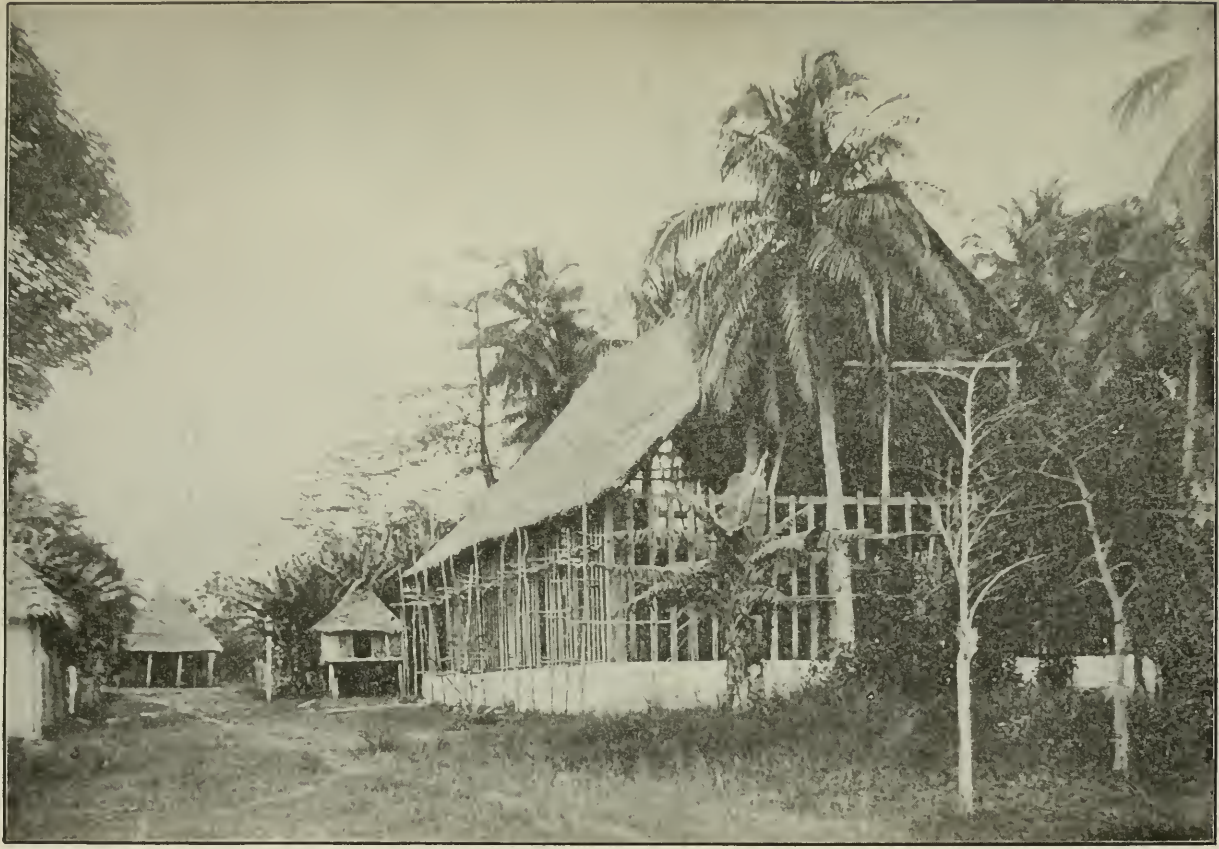
A fleet of Franciscan missionaries being in Seville, in the year 1576, ready to sail for the Solomon Islands, Philip II obtained the permission of Pope Gregory XIII that they should go to evangelize the Philippines, where they arrived the 24th of June, 1577, being received in Manila with enthusiastic demonstrations of joy. They soon founded a religious province, which they called St. Gregory the Great. The grand marshal, Don Gabriel de Rivera, built them the convent of San Francisco the same year, 1577. The holy martyr of Japan, Father Pedro Bautista, Franciscan, was the founder of the convent of San Francisco del Monte, outside of Manila. The convent of Franciscan nuns of Santa Clara was founded in 1620, its first mother superior being Geronima de la Asuncion. A porter of the convent of San Francisco, of Manila, was the founder of the hospital of St. Lazarus in 1598, which afterwards, in 1603, was located outside of Manila. The Franciscan missionaries were the first missionaries of Samtaloc, Pandacan, Santa Ana, Meycauayan, Bocaue, Morong, Baraa, Pagsaughan, Santa Cruz de la Laguna, and Mainit, where were established some baths of hot sulphur water from the springs in that locality. In this same province of Laguna they founded Nagcarlang, Lilio, and Mahayhay, and some missions in the mountains of Daraetan.

They were the apostles who evangelized and converted to Christianity the provinces of Camarines. In the province of Tayabas they established the towns of Pagbilao, Sarriaya, Lueban, and others; the missions of Lupe and Ragay, those of the mountains of Mangairia, and on the opposite coast the Christian communities of Binangonan, Polo, Baler, and Casiguran. These distinguished missionaries of the glorious San Francisco extended their apostolic zeal even to the islands of Japan, where 23 canonized martyrs and 40 blessed ones shed their blood for Jesus Christ.

A lay brother named Friar Antonio de San Gregorio, who was the corner stone of this holy and apostolic province of St. Gregory the Great, was able to give all this glory to God.

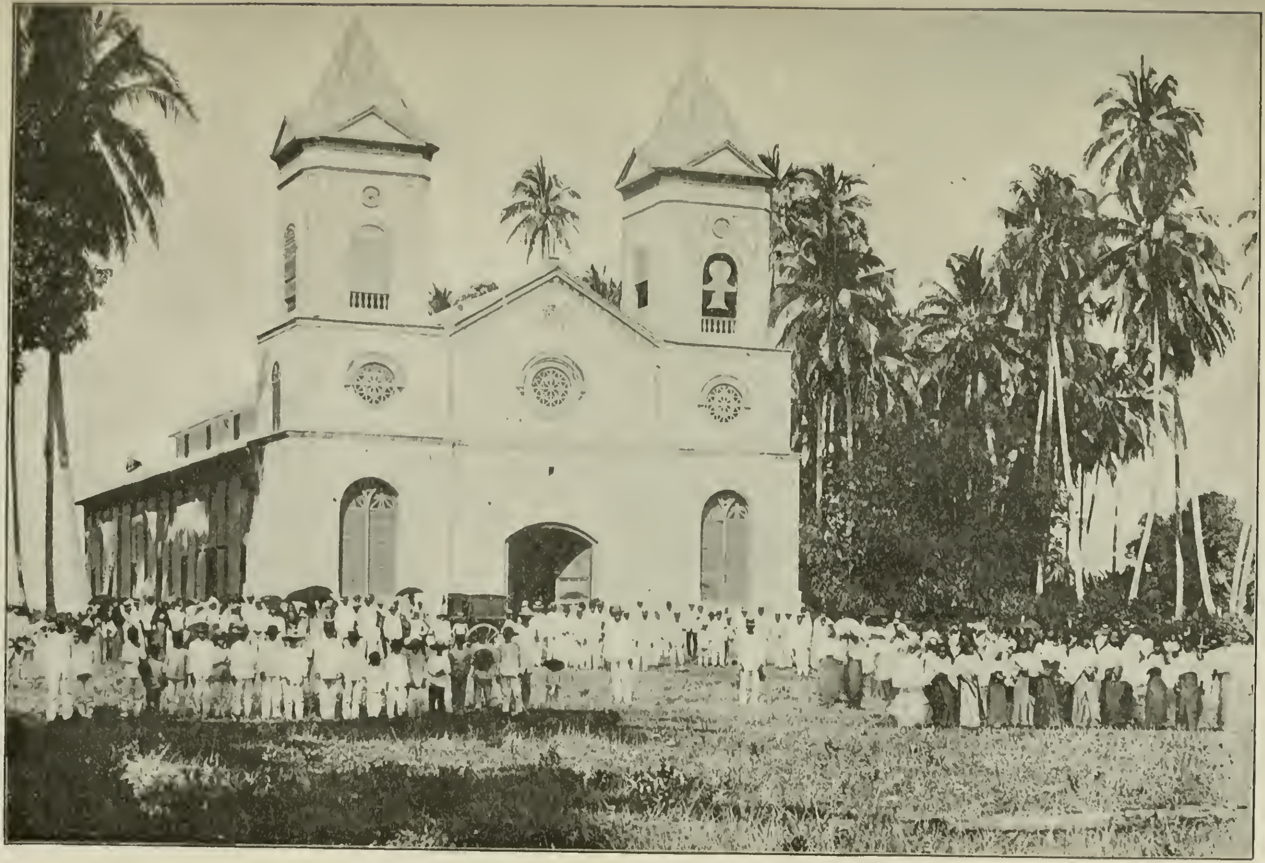
To these two missionary bodies was added a third, that of the Society of Jesus. As the sons of Ignacio have everywhere marched in the vanguard of Catholicism, it could not fail to happen that they should wish to emulate the distinguished sons of San Francisco and San Augustine in the Philippines by dauntlessly following the footsteps of the Apostle of the Orient and their brother, St. Francis Xavier. The Jesuit fathers who arrived at these islands in 1581 in company with the first bishop, Domingo de Salazar, of the Order of Preachers, were two only; but it would be hard to find two men who have rendered greater services to the Philippines. There names were Antonio Sedeño and Alonzo Sanchez. Father Sedeño, a native of the town of San Clemente, province of Cuenca, in Spain, followed in his youth the career of a soldier under the orders of the Duke of Frias, at which time he studied the art of fortification. He afterwards pro-

PLATE II.



CHURCH IN COURSE OF CONSTRUCTION (1895) AT MATI.

PLATE III.



CHURCH OF SANTA MARIA (ZAMBOANGA).

fessed in the Society of Jesus, and was a missionary in Florida. He taught the Filipinos to sew cloth, to cut stone, and to make mortar. He built the Episcopal palace, procured quantities of seeds, taught them to spin silk, planted mulberry trees, set up looms, had painters come from China, opened the first school in the Philippines, founded the colleges of Manila and Cebu, and sent out missionaries all through the Visayas. He died in peace after fourteen years of apostleship. Father Alonzo Sanchez was sent as an ambassador tc Macao, and then to the courts of Madrid and Rome to negotiate with the King of Spain and with the Pontiff the establishment of the fundamental bases and the relief of the most urgent necessities of the infant colony. It was he who obtained from Philip II the support of the colony against the opinion of the counselors of the Crown, who thought it should be abandoned on account of the large expense it occasioned without giving any return.

The King, influenced by the reasoning of Sanchez, energetically supported his proposal for love of the salvation of the souls of the poor Indians. The principal measures which he obtained from the King and from the Pope were: The preservation of the cathedral; the sending out of missionaries of the different religious orders at the expense of the State: the founding of two hospitals, one for Spaniards and the other for Indians; the founding of the college of Santa Potenciana for Spanish girls; the imposition of a 3 per cent tax on goods in the custom-house; and besides, that from each tax one-half real should be taken for the support of the ministers and holy objects of the church; that the debts of the first Spaniards who arrived in the islands at the expense of the State should be paid; that the Governor-General of the Philippines should not confer offices on his relatives, but on people who had worked in the country for three years; that in the lawsuits of the Indians he should proceed summarily; that slavery should be abolished by freeing the children of slaves; that the army should be well provided for from the royal treasury of Mexico; that soldiers in active service could not engage in trade; that the city of Manila should be fortified; that four strongholds should be constructed in the archipelago, defended by a powerful squadron; that, in view of the distance, the Governor-General should have unlimited power in case of need; the consent of the bishop, of the audiencia, and of the chiefs of the army being sufficient.

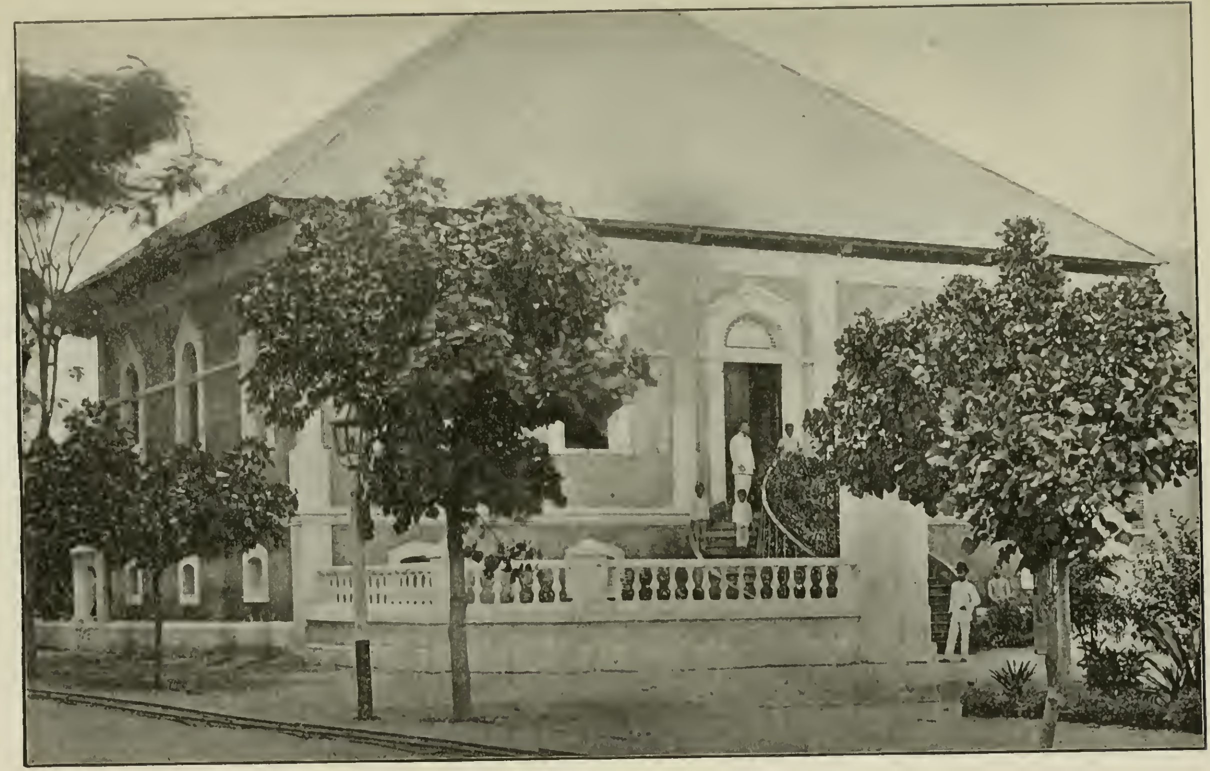
The Jesuits founded the royal college of St. Joseph in 1595, and then that of San Ignacio, which was raised to the rank of pontificial university in 1621 and royal in 1653; the community of Santa Cruz, that of San Miguel, and the Noviciado de San Pedro Macati. In the mountains of the country of the Tagalos they built the sanctuary of Antipolo, where they placed the miraculous image of Nuestra Senora de la Paz y Buen Viaje, the object of the pilgrimages of the pious Filipinos. In Cavite they established the missions of Cavite, Viejo, Silang, Indang, and Maragondon. They devoted themselves to the study of Tagalog and filled their large libraries with Tagalog books. But as the Tagalo provinces already had missionaries of other religious orders, the Jesuits hastened to the evangelization of the Visayan Islands; they established a central college in Cebu, and from there they undertook a spirtual campaign against error, ignorance, superstition, and vice, which lasted for two centuries and which extended throughout the islands of Bohol, Negros, Leyte, Samar, Mindanao, Marianas, and Carolinas. In Bohol, from 1597 to 1622, Fathers Gabriel Sanchez and Juan Torres founded the missions of Loboc, Baclayon, Danis, Malabohoc, San Miguel, Talibon, and Inabanga; in Negros, the towns of Ilog and Cabancalan. In Leyte Fathers Chirino, Jimenez, Carpio, and others founded the towns of Leyte, Palompon, Ormoc, Baybay, Hilongos, Maasin, Sogor, Cabalian, Carigara, and many others. Fathers Otazo, Ponce, Miralles, and Damián passed over to the mountainous island of Sámar, wall of the Pacific Ocean, and reduced it all to orderly life. By studying the language and reducing it to writing, they composed dictionaries and elegant books, and gathered together twenty centers of population, not without infinite labor, shipwrecks, captivity, and the martyrdom of some of their missionaries. In Guinang, a town of said island, Father Delgado wrote his copious history, in the year 1790.

From Sámar, Leyte, and Bohol the Jesuits proceeded to the evangelization of Butúan and Dapitan, in Mindanao; and toward the south they reached Zamboanga, Basilan, and Joló, accompanying the Spanish squadrons, who were fighting against the Moros. Father Sanritores, with a few companions, evangelized the Marianas Islands, where he was martyred by those islanders in 1670, after having baptized 13,000 of them and leaving 20,000 catechumens. And still the zeal of the Society of Jesus was not satisfied, and during the last century it did not cease sending various expeditions to the Caroline Islands, which were not successful, because the majority of the missionaries perished, victims of the furious typhoons which are so frequent in those seas.

After the Jesuit missionaries the Dominican fathers arrived in the Philippines in the year 1587. In order to understand the great benefits which these most learned fathers have conferred on the islands, read the magnificent History of the Province of Santísimo Rosario, written by Father Fonseca, for it would be a task little less than impossible to reduce to a brief sketch all their labors and enterprises in Luzón, Formosa, and in the vast Empire of China. The first bishop of Manila, Rev. Father Domingo Salazar, was a Dominican, and from the Dominican monastery of that city there have gone out a multitude of wise and holy prelates, who have occupied the sees of the East, and even many of the sees of Spain, to the glory of their order and the Holy Catholic Church, which they have extended in the Orient.

The image of Our Lady of the Rosary, which is venerated in the Church of San Domingo, is celebrated in all the islands, and there is no more popular feast than that called Naval, which is held yearly, the first Sunday in October, in said city of Manila. Their University of St. Thomas, founded in 1620, confirmed as the Pontifical University in 1640 and as the Royal University in 1680, has been the most lasting center of learning of all those founded in the Philippines, and has had professors as learned as Cardinal Ceferino Gonzalez. These missionaries scattered themselves throughout the provinces of Batuán and Pangasinán, and reduced them all to Christianity. The government of the Sangleys or Chinese Christians was intrusted to them. It was not long after their arrival when they extended their missions throughout Cagayán and the Batanes Islands. Their zeal not being satisfied with such a vast field, in 1626 Friar Bartolomé Martínez, provincial of the Dominicans, with five other monks of his order, navigated to the island of Formosa, where they established several missions. In 1633 Father Juan de Morales was sent out to organize

PLATE IV.



MISSION HOUSE OF JOLO.

the missions of Fokieu, in China, which have been maintained in a flourishing state to the present time. In 1676 Fathers Juan de la Cruz, Arjona, and Morales crossed to Tonquin and were the founders of the Spanish mission in that Kingdom, where the Christian religion has been propagated in a marvelous manner in spite of the persecutions suffered, and in which 12 Spanish Dominicans, 6 of them bishops, 26 native Dominicans, and more than 5,000 Christians died as martyrs. But now Christianity had so increased in Tonquin that Pius IX created for its ecclesiastical government two apostolic vicarages, and Leo XIII added a third, the three now being named Oriental, Northern, and Central.

The great sacrifices made for a holy cause are an example and stimulus for noble souls. Thus we see that the Fathers Recoletanos, of the Order of St. Augustine, being holily jealous of the pains, labors, and triumphs which other religious bodies had had in the conversion of the Philippines, came to these islands in the year 1606. Their first missionary was the venerable Father Juan de San Geronimo, who renounced the Bishopric of Chapa, in America, to devote himself to the spiritual conquest of these lands, as the humblest of the followers of the Gospel. Without allowing themselves a moment of rest, the Recoletos Fathers began their apostolic journey, evangelizing the mountains of Mariveles and the province of Zambales, where they made the echoes of their inspired words resound. In the southern part of the archipelago there is the large and most fertile island of Mindanao, the home of Moro piracy and of the obscene errors of the Koran, against which these missionaries declared war without truce or quarter. The most celebrated of them all, in Philippine history, is Father Pedro de San Agustín, called Father Captain. The glorious deeds of this vigorous champion of the faith appear incredible. He was the first who, about the year 1835, penetrated to the Lake of Lanao and inspired the fanatical followers of Mohammed with terror, since they not only did not wish to be converted, but devastated the Christian communities which the father had established with so much trouble and labor in the north of Mindanao.

The island of Romblón was the prey of the Mussulman piracies, and there Father Captain went, obeying the orders of his superiors, humiliating the power of the Moros (Mohammedans) in those seas, and constructing bulwarks such as those of Bantón and Punta Ragacay, which demonstrate a very superior knowledge not only of military architecture, but also of ballistics. The flourishing state of religion in those islands proves how great the Lord is, who from a peaceful monk could make a bold captain and apostle of these regions.

In the Calamianes Islands, in Paragua, Mindoro, in the island of Tablas, in Masbate, in that of Burias, in that of Ticao, in the most fertile island of Negros, and in the province of Cairte, the Recoletanos Fathers have established numerous missions and parishes, which will be a monument of their zeal and the fruitfulness of the Catholic Church. Besides, they promoted the arts and agriculture, building in Manila an iron gothic church, called San Sebastián, and cultivating in the province of Cavite the famous plantation of Imus.

To the labors of these five missionary bodies we have just mentioned, namely, the Augustinians, the Franciscans, the Jesuits, the Dominicans, and the Recoletanos, must be added the work of the secular clergy, composed in part of Spanish clergy and in part of native clergy. To them is due the maintenance of worship in the cathedral churches of Manila, Cebú, Jaro, Nueva Caceres, and Nueva Segovia. The native clergy already in the last century administered 16 curacies in the Archbishopric of Manila, 15 in the Bishopric of Cebú, 18 in that of Camarines, and 4 in that of Cagayán or Vigan, and they are the ones who up to the present time have held the office of coadjutors of the rectors in the large parishes of the rest of the archipelago. Their knowledge of the languages of the country in which they were brought up makes them very well fitted for the ministry of the Word and for the administration of the sacraments to the Indians. They have not failed to give eminent men to the Philippine church.

ESTABLISHMENT OF THE ECCLESIASTICAL HIERARCHY.

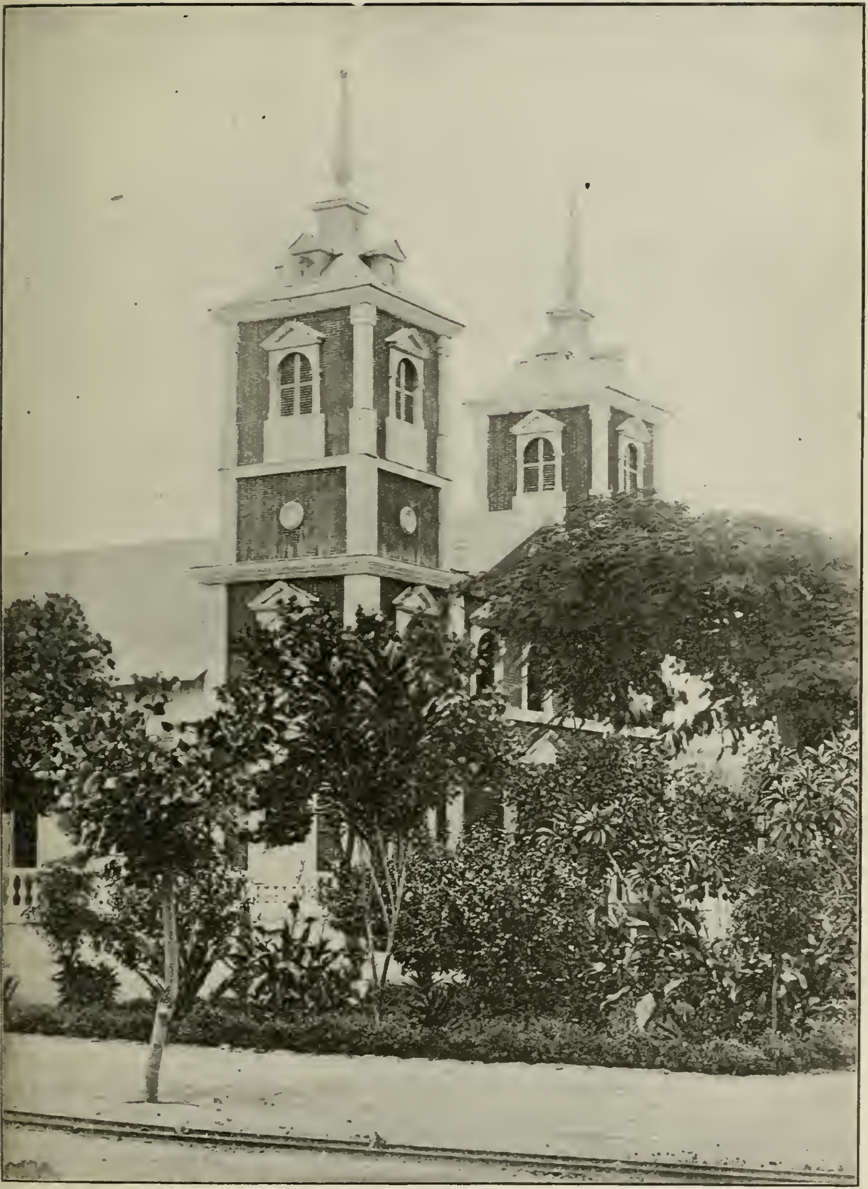
The Philippine Church could not exist without ecclesiastical hierarchy, and indeed Philip II selected at once Father Domingo Salazar, master in theology of the Monastery of St. Stephen in Salamanca, of the Order of Preachers, as the first bishop of the Philippines, and Pope Gregory XIII approved his selection and he was consecrated in Madrid in the year 1579, arriving at Manila in 1581. The series of most illustrious bishops and archbishops of this see can be found, together with an account of their principal enterprises, in the history written by Father Delgado of the Society of Jesus, Book 2, Chapter X. Among the preeminent pontiffs there are worthy of mention, besides Salazar, Santibañez, raised to the dignity of archibishop in 1598; Benavides, founder of the University of St. Thomas, who died in 1616; Guerrero, intrepid defender of the ecclesiastical jurisdiction, who died in 1641; Miguel Poblete, Mexican priest, who died full of merits and virtues in 1667; Diego Camacho, most zealous for the splendor of the cathedral and a great lover of the seminary, who rested in peace in the year 1712; Rodriguez, who died in 1742, and others whom we do not mention for the sake of brevity. All of them distinguished themselves by their love for the Indians, protecting them with their episcopal authority, which is greatest among the ecclesiastics of the Far East. The archdiocese of Manila is one of the most extensive and populated of the Catholic world, and has to-day subject to it the episcopal chairs of Cebú, Nueva Segovia, Nueva Cáceres, and Jaro.

FOUNDATION OF THE DIFFERENT DIOCESES.

The diocese of Cebú was founded in 1535, and Father Pedro de Agusto, of the Order of St. Augustine, was elected as its first bishop, and governed it holily until 1608. The illustrious Arce succeeded him, who died in 1642. Several other most edifying prelates succeeded him, among those worthy of mention being Miguel Bayat, barefooted Franciscan, who when he died had but five reals, because he gave all his treasures to the poor.

This diocese was so extensive that it included, before that of Jaro was created, all the Visayan Islands, Mindanao, Jolo, the Marianas, and the Carolines. The life of man was too short to visit it, and it was necessary to divide it, as was done in 1865.

The diocese of Nueva Cáceres, or of Camarines, was created by apostolic brief of Clement VIII, in the year 1595, at the same time as that



CHURCH OF JOLO.

of Cebú, and its first bishop was Francisco de Otorga, Augustinian monk, who died in 1601. His successors were generally apostolic men taken from the monasteries and the missions; although there were seated in this chair, as in the rest of the archipelago, priests of the secular clergy, as illustrious, zealous, and charitable as Felipe de Molina, native clergyman of the town of Arévalo, in Iloilo, who repaired the ruins of its church and governed the diocese apostolically.

The first Bishop of Nueva Segovia was Miguel de Benavides, who ruled over the church from 1599 to 1603, when he was promoted to be Metropolitan of Manila. He was succeeded by other learned men of much power, some of whom were also transferred to the archiepiscopal chair of Manila, such as the illustrious Serrano and José Millán de Poblete; and still more worthy of mention is what happened with Father Juan Arrechedera, Dominican monk, who, at the same time he was Bishop of Nueva Segovia, was elected by decree of the royal audience to fill the office of governor and captain-general of the islands, on account of the death of Don Gaspar de la Torre, and he held the staff of the supreme command of these islands from the year 1745 to 1750, being very much beloved by the Indians. In truth, this Philippine colony did not need soldiers for a period of three centuries to maintain order, or even to defend itself from foreigners, because religious influence substituted with advantage military force, and it was lost only when the Spanish Government allowed this religious influence to diminish.

The diocese of Jaro was created by bull of Pope Pius IX in 1865, its first bishop being Mariano Quartero, who died in 1884. Leandro Arrúe, of the Order of Recoletanos, succeeded him, who died in 1897, Andrés Terrero de San José, monk of the same order, being elected to succeed him.

In all the dioceses the bishops took care to found seminaries for the native clergy, not only because they were necessary to assist in the administration of the sacraments in the large parishes created by the monks, but also in order that they could occupy some district parishes which from very old times had been reserved for them.

THE FATHERS OF THE CONGREGATION OF ST. VINCENT DE PAUL, THE CAPUCHINS, AND THE BENEDICTINES ARRIVE AT THE ISLANDS.

To govern some of these seminaries there came from Spain in 1862 the Sons of St. Vincent de Paul, together with the Sisters of Charity, who took charge of the attendance on the sick in hospitals and of the instruction of girls.

The Capuchin Fathers also arrived in these islands in 1886 for the purpose of taking charge of the missions of both the Caroline and Palaos islands—an office which they have filled in a marvelous manner, not without the sacrifice of all earthly ambitions, going to bury themselves forever in those solitary places of the Pacific Ocean for love of the poor natives.

Finally, in 1895, the Benedictine Fathers of the Monastery of Montserrat, in Spain, disembarked for the first time in Manila to take charge of some missions on the eastern coast of Mindanao.

WONDERFUL TRANSFORMATION OF THE PHILIPPINES.

What a beautiful page for the Catholic Church the history of the propagation of Christianity in the Philippines presents! What fruitfulness on the part of the Church! What glory for the missionaries! What honor for Spain! The monks arrived at these islands in the year 1565. They found in them about 2,000,000 inhabitants; some of them wholly savage, cannibals, others semibarbarous; all of them pagans, idolaters, sunk in the densest darkness of superstition, slavery, and vice. But what was the condition of the Philippines one century later? The barbarians had already been reduced to civil and orderly life; idolatry had disappeared; slavery had been abolished; matrimony had been sanctified; thousands of children attended the schools, magnificent churches had been erected, and 1,000,000 inhabitants had received the waters of baptism and practiced the Christian religion, just as those born in Europe. In the succeeding century the number of Catholics became 2,000,000, and soon 6,000,000.

This is the work of the Catholic Church and of the Catholic Spanish nation, true mothers, the one spiritual and the other temporal, of this fortunate colony; the most pious spirit of both dictating the benevolent dispostititions and concessions of the Popes and of the Philippine episcopate, and the most magnanimous and humanitarian laws of the never sufficiently praised code of the Indies, so suited to the capacity and so protective of the rights of the Indians, that it seems rather to come from the good heart of a Pontiff than from a temporal monarch—a true model of Christian secular legislation. These two powers and legislations, ecclesiastical and political, always working with the most admirable harmony during the first three centuries, were the two agents, but in spirit one, of this work of culture, which has no equal in the history of colonial civilization.

PRESENT STATE OF THE CATHOLIC RELIGION IN THE PHILIPPINES.

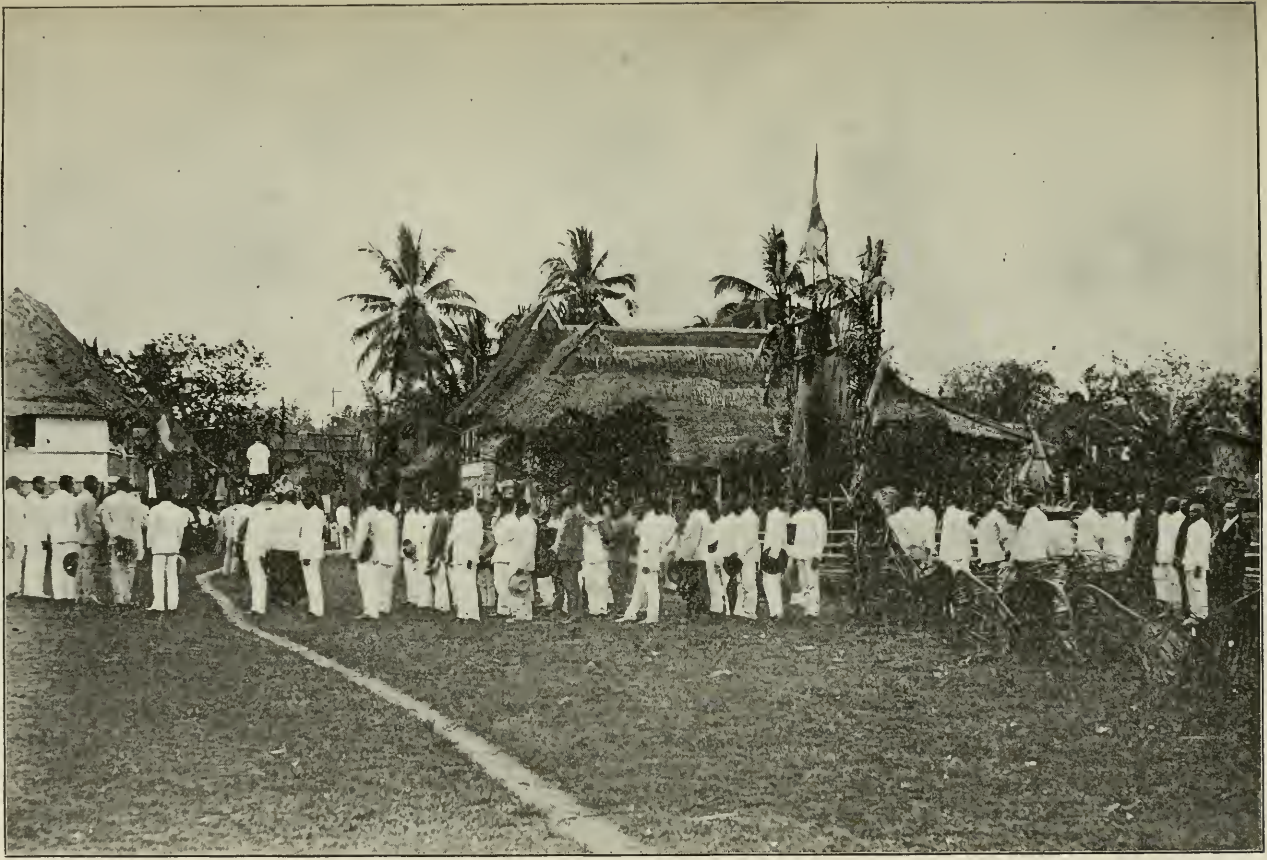
PROGRESSIVE INCREASE OF CATHOLICS IN THE PHILIPPINES UNTIL 1898.

In order to understand the present state of the Catholic religion in the Philippines (we refer to the year 1896, before the Tagalo insurrection) it would be well to put before the eyes of the reader the growth of the Christian population and the increase of the faithful from the time of the arrival of the Spaniards until the present time.

The number of inhabitants which the Spaniards found on their arrival in these islands is not definitely known, but it is estimated by some historians as less than 2,000,000, and it would not be imprudent to affirm that it scarcely reached 1,500,000, all of them either idolaters, who admitted a plurality of gods, or Mohammedans, who, although they professed, as they still do, the unity of God, did not believe, nor do they yet believe, in the divinity of Jesus Christ, but rather have almost always been instructed from their earliest youth by their parents and teachers to hate Christianity.

Then the Spanish missionaries arrived and began the work of evangelization, at the same time as the humanitarian undertaking of reducing them to political life, because the majority of the Indians and Moros lived scattered about on the shores, fields, and in the woods, forming little ranches.

PLATE VI.



PROCESSION OF NATIVES (BOLONG, ZAMBOANGA).

What was the result of their apostolic labors? Let us see. Juan Francisco de San Augustín, chronicler of the Franciscan missionaries, gives us the following:

General résumé of souls, not taking into account more than the natives converted to Christianity in all the Philippine archipelago in the year 1735.

In 142 towns which the clergy have in their charge in all this archipelago	131, 279
Shod Augustinians (in more than 150 towns)	241, 806
Order of San Domingo (in 51 towns)	89, 752
Society of Jesus (in 80 towns)	170, 000
Augustinian Recoletos (in 105 towns)	63, 149
Barefoot Franciscans (in 63 towns)	141, 196
Total	837, 182

Father Delgado, who wrote about the year 1750, gives almost the same statistics, but adds these words:

> I do not doubt that the souls ministered to by the secular and regular priests in all the islands of this archipelago exceed a million and many thousands more, because in the church registers children under 7 years are not entered or enumerated, and so I am depending on the count which was made a few years ago.

In the work entitled "State of the Philippine Islands," written by Don Tomás de Comyn in 1820, and translated into English by William Walton in 1821, there is an appendix, as follows:

Recapitulation of the population of the Philippines.

Indians of both sexes (Catholics)	2, 395, 687
Chinese half-breeds (Catholics)	119, 719
Sangleyes, or Chinese	7, 000
Whites	4, 000
Total population	2, 526, 406

Comparison of the total population in 1791 and 1810.

	Year 1791.	Year 1810.	Increase.
Indians	1, 582, 761	2, 395, 687	812, 926
Half-breeds	66, 917	119, 719	52, 802
Total	1, 649, 678	2, 515, 406	865, 728

And he concludes, saying:

> The difference resulting from the foregoing comparison, founded on public documents, gives an excess of 52 per cent of increment in each eighteen years, and if said proportion continues, the population of the Philippine Islands will be doubled in thirty-four years, an increase which might be considered incredible if we did not have an extraordinary example in Philadelphia, which has doubled its population in twenty-eight years, as Buffon affirms, on the authority of Dr. Franklin.

This remark of Mr. Comyn has already been realized with accuracy, if we hold to what Don Felipe del Pan, a studious newspaper man of Manila, assures us of in his published works; for, according to this author, in 1876 the population of the Philippines amounted to 9,000,000 individuals.

Mr. Ferreiro, secretary of the Geographic Society of Madrid, also estimated the population of the Philippines in 1887 to be approximately 9,000,000, a figure which to some appears to exceed the true number.

In a study made the last three months of 1894 the population of the archipelagoes which were under the general government of the Philippines appeared as follows:

Christian parochial population	6,414,373
Refugees	128,287
Regular and secular clergy	2,651
Spanish and Indian soldiers	21,513
In asylums	689
Criminals	702
Chinese foreigners	74,504
White foreigners	1,000
Mohammedans	309,000
Heathen	880,000
Total	7,832,719

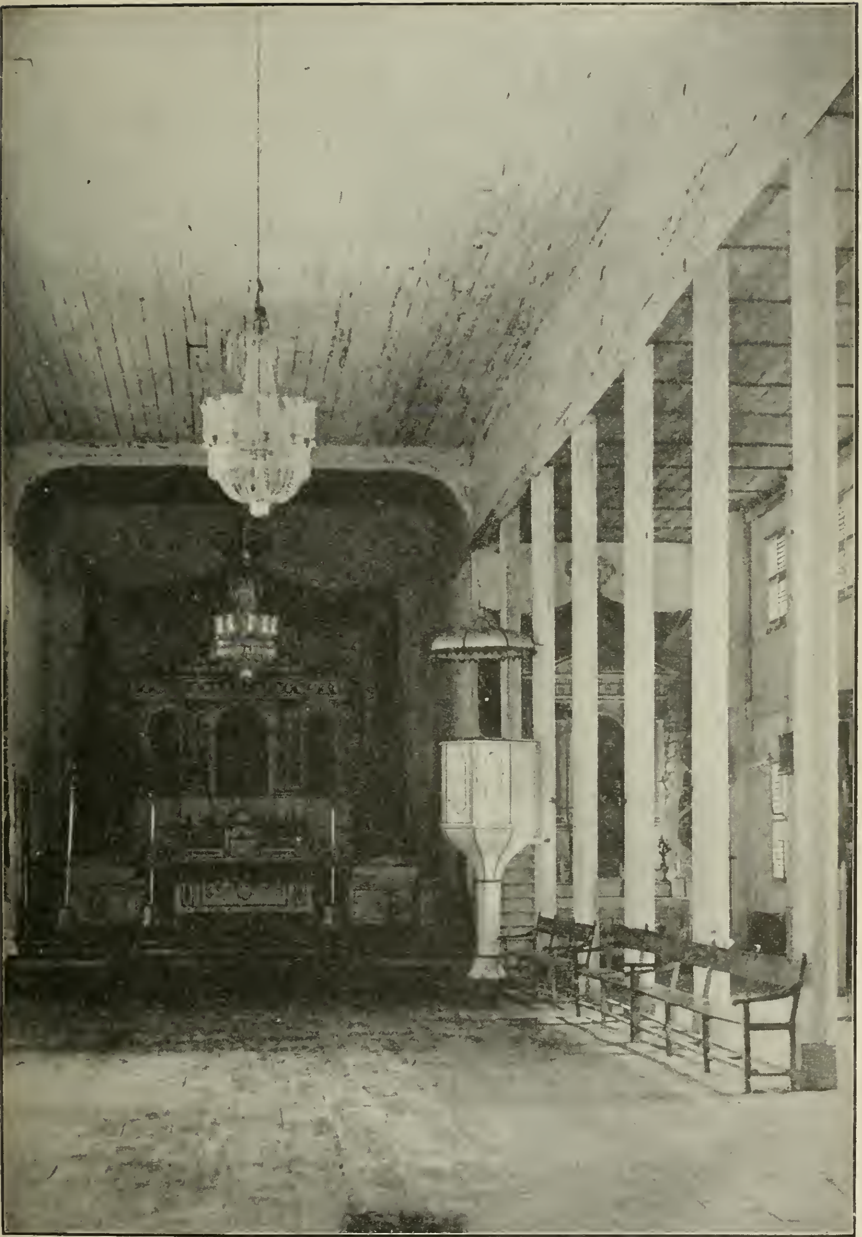
Finally, the secretary of the archbishopric of Manila offers us the following census with relation to the Catholics in the Philippine, Marianas, and Caroline archipelagoes in the year 1898, according to the parochial registers:

Number of persons per diocese.

Archbishopric of Manila	1,811,445
Bishopric of Cebú	1,748,872
Bishopric of Jaro	1,310,754
Bishopric of Nueva Segovia	997,629
Bishopric of Nueva Cáceres	691,298
Total number of Catholics	6,559,998

To whom is due this increase of Catholicism and this growth of the population of the Philippines in general from the time of the Spanish conquest? It is due to the regular and secular clergy. Scarcely any importance can be attached to the immigration into the Philippines in the course of years. The Chinese and the Europeans, including the Spaniards themselves, may be considered, as a general rule, birds of passage, who come to pass a few years here and then return to their own country. The Philippine population has increased, thanks to the organization and good government of the centers of population, principally established by the action of missionaries at the time of the conversion to Christianity of the natives of the evangelized territories. The secular power, even aided by arms, did not attempt to create towns of infidels. Not even the military posts have become populous or permanent towns.

The center of attraction and of permanence in Philippine towns has always been, and continues to be, the church and the monastery. The parish priest, who is not a bird of passage, is generally the most respected authority, the chief guarantee of peace and order, and the most zealous guardian of morality, the undoubted and most important cause of the increase in the population of any country. The numerous and important towns, which now have other powerful roots and elements of cohesion, began and grew in this way. Take away from them, especially when recently founded and young, the center of union of which we have spoken, and it will be seen how the families will separate and the new citizens readily return to the life of the mountains.



INTERIOR OF CHURCH AT TETUAN (ZAMBOANGA).
Usual form of Jesuit missionary church in Mindanao.

PRESENT STATE OF THE ARCHBISHOPRIC OF MANILA AND THE BISHOPRICS OF CEBÚ, JARO, NUEVA CÁCERES, AND NUEVA SEGOVIA.

To shepherd this flock of 6,500,000 Catholics the church of the Philippines has an archbishop and four bishops.

The present archbishop of Manila is Don Bernardino Nozaleda, of the Order of St. Dominic, a wise and prudent prelate, who took possession of his chair the 29th of October, 1890. This archdiocese has a magnificent cathedral and a considerable chapter, which in the time of Spanish dominion was composed of 24 prebendaries. The ecclesiastical court has its offices in the archiepiscopal palace. The seminary of the council is a beautiful edifice and is governed by the Fathers of the Congregation of St. Vincent de Paul. It is now closed on account of the state of war which exists in the country. The pious works of the miter before the revolution counted upon a considerable fund, and they are in charge of an administrator. The archbishopric of Manila has 219 parishes, 24 parish missions, 16 active missions, 259 parish priests or missionaries, and 198 native clergymen to assist the parish priests.

The diocese of Cebú is ruled over by Don Fr. Martín García de Alcocer, of the Order of St. Francis, a most worthy prelate and very much beloved by all those in his diocese. He took possession of his diocese the 11th of December, 1886. In Cebú there is an old cathedral, and they were building a new one when the revolution broke out. Besides, that city has a conciliar seminary, in charge of the Paulist Fathers, and two hospitals dependent on the miter. The diocese hta 166 parishes, 15 parish missions, 32 active missions, 213 parish priesss or missionaries, and 125 native clergymen.

On account of the death of Father Leandro Arrúe, which occurred in 1897, D. Fr. Mauricio Ferrero, ex-provincial of the monks of the Recoletano Order of St. Augustine, has just been appointed bishop of Jaro. The bishopric of Jaro has a cathedral church, which is at the same time the parish church of the city of Jaro, with the corresponding ecclesiastical court, and a seminary governed by the Fathers of St. Vincent de Paul. There are in the diocese 144 parishes, 23 parish missions, 33 active missions, 200 parish priests or missionaries, and 73 native clergymen employed in the parochial ministry.

The diocese of Nueva Cáceres has for its bishop D. Fr. Arsenio del Campo, of the Order of St. Augustine, who took possession of his chair the 3d of June, 1888. Although it lacks a chapter, as the dioceses of Cebú, Jaro, and Nueva Segovia, there is, nothwithstanding, in Nueva Cácere sa cathedral church, ecclesiastical tribunal, conciliar seminary in charge of tbe Paulist Fathers, and a leper hospital. The bishopric of Nueva Cáceres has 107 parishes, 17 parish missions, 124 parish priests or missionaries, and 148 native priests.

The present bishop of Nueva Segovia is Don Fr. José Heria Campomanes, a monk of the Dominican Order, very well versed in the Tagalo language, who previously had been for many years parish priest of Binondo, which parish he enriched with a magnificent cemetery. He took possession of his chair on the 19th of June, 1890, but, the revolution having broken out, he was made a prisoner, and at the present writing he is still groaning under the painful chains of captivity, and not always treated as his sacred character, his authority, and his personal qualifications merit. The diocese of Nueva Segovia has 110 parishes, 26 parish missions, 35 active missions, 171 parish priests or missionaries, and 131 native priests. The ecclesiastical court is located in Vigan, where there is, besides, a cathedral church and a conciliar seminary, which have been governed up to the present time by the monks of the Order of St. Augustine.

STATE OF THE RELIGIOUS BODIES.

The Corporation of Augustinian Fathers (shod) had, before the revolutionary movement, the fine monastery and church of San Augustín in Manila, those of Cebú and Guadalupe, and the orphan asylums of Tambobong and Mandaloyan; and in Spain the colleges of Valladolid, of Palma de Mallorca, and of Santa María de la Vid, with the Royal Monastery of the Escorial and the hospitium of Barcelona, besides a mission in China. The total number of monks was 644.

The Corporation of Recoletos, Augustinians, also had, before the war in the Philippines, a monastery and church in Manila, churches in Cavite, San Sebastian, and Cebú, and the plantation house at Imus; and in Spain the colleges of Monteagudo, of Marcilla, and of San Millán de la Cogulla, the number of monks being 522.

The monks of the Order of St. Francis have in the Philippines their monastery and church in Manila, and that of San Francisco del Monte, the Hospital of St. Lazarus, the church of the Venerable Third Order of Sampáloc, the almshouse of San Pascual Baylón, the infirmary of Santa Cruz de la Laguna, a leper hospital in Camarines, the college of Guinobatán, and the monastery of Santa Clara; and in Spain the colleges of Pastrana, Consuegra, Arenas de San Pedro, Puebla de Montalbán, Almagro and Belmonte, with a residence in Madrid, and besides a college in Rome. The total number of monks is 475 and of nuns 34.

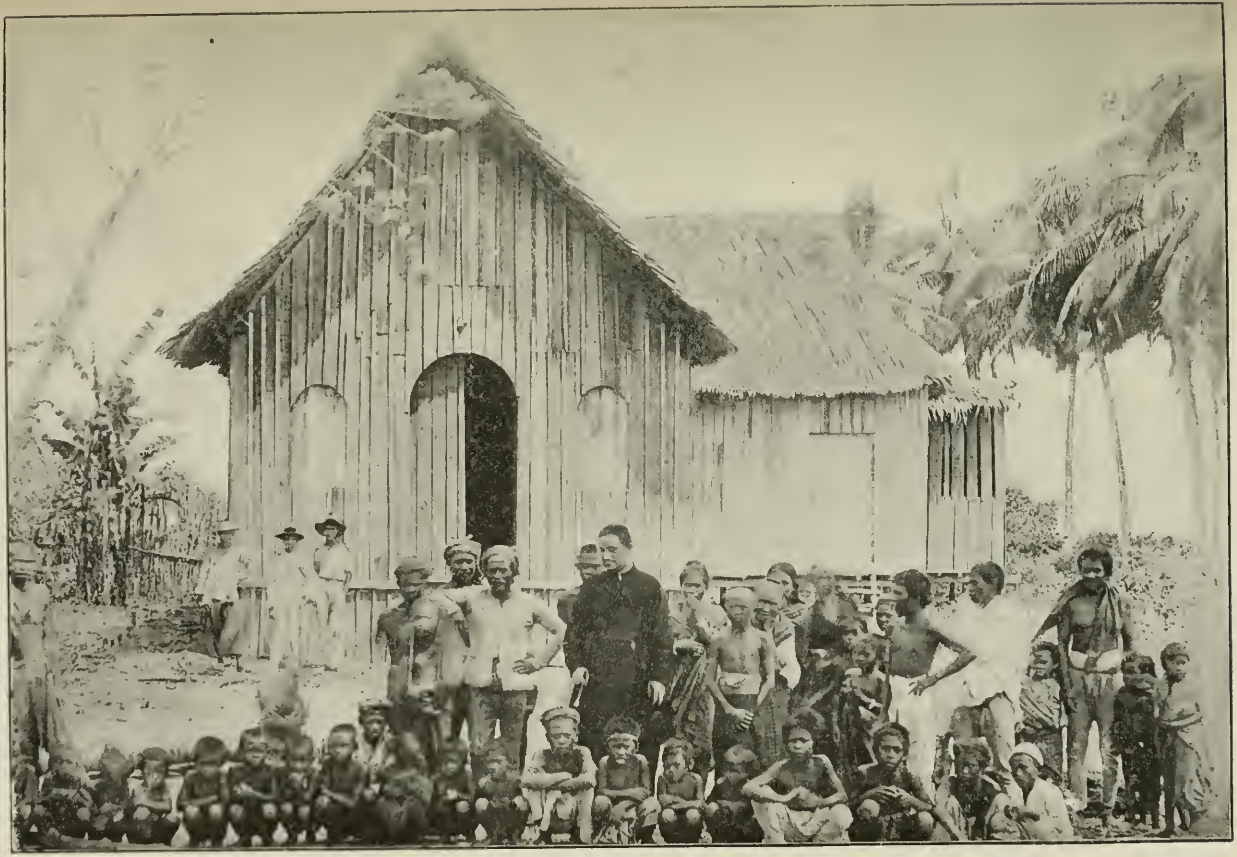
The monks of the Order of St. Dominic, besides the missions in China and Formosa, have in Manila the convent and church of San Domingo, the university of San Tomas, the college of San Tomás, that of San José, and that of San Juan de Letrán, the college of San Alberto Magno in Dagupán, the vicarage of San Juan del Monte, and of San Telmo in Cavite, the nunnery of Santa Catalina de Sena in Manila for girls, that of Our Lady of the Rosary in Singayén, that of Santa Imelda in Tuguegarao, and that of Our Lady of the Rosary in Vigan, also for the education of girls; and in Spain the two colleges of San Domingo de Ocaña and San Tomás de Ávila, with a total number of 528 monks.

The missionaries of the Society of Jesus have in Manila a central mission house and municipal school, the normal school, and a meteorological observatory, and they administer 37 missions, with 265 stations or settlements of converts in Mindanao, Basilan, and Joló. The total number of Jesuits resident in the Philippines was only 164, but the province of Aragón, to which the mission belongs, has several preparatory houses, colleges, and residences in Spain besides those it supports in South America.

The fathers of the Mission of San Vicente de Paul have the house of San Marcelino in Manila and the conciliar seminary of that city, with also those of Cebú, Jaro, and Nueva Cáceres.

The Capuchin missionaries have the church and mission house in Manila, the mission of Jap in the Western Carolines, that of Palaos,

PLATE VIII.



MISSIONARY AMONG THE MOROS (PANIGAYAN, BASILAN).

that of Panapá, in the Eastern Carolines, and the procuration of Madrid, the total number of monks being 36.

The Benedictine missionaries occupy the Central Mission House in Manilia, the missions of Taganaán, Cantilan, Gigaquit, Cabúntog, Numancia, and Dinagat in Mindanao, and a college of missionaries in Montserrat (Spain). Those resident in these islands number 14.

In conclusion, there are in the Philippines, besides the monks, several nunneries dedicated, some to contemplation, such as those of Santa Clara; others to education, such as those of Asunción, the Dominicans, and the nuns of the Society of Jesus; and, finally, others to the practice of charity, such as the Sisters of Charity or of St. Vincent de Paul, who have in their charge the hospitals, although they also devote themselves with great success to the instruction of girls in the colleges of Concordia, Santa Isabel, Santa Rosa, Escuela Municipal, Looban, Hospicio, San José in Jaro, and Santa Isabel in Nueve Cáceres.

RELIGIOUS SPIRIT OF THE COUNTRY.

After this superficial account of religious statistics, we can not resist the desire to set forth, although very briefly, what is at present and in reality the character or qualities of the religious spirit reigning in this country, which owes all that it is, aside from purely natural elements, to the Catholic civilization of Spain. Moreover, the point is very pertinent to the subject.

It is indisputable from the very beginning that the native masses who have received the direct influence of the Spanish civilization are wholly Catholic. The infidel natives are still barbarous or semibarbarous; and the Moros, besides lacking the civilization of the Christian Indians, only retain of merely external Mohammedanism their innate pride and treachery, and a few formalities known and practiced by a very small number of their race. Those in the Philippines who profess, or are said to profess, any other positive religion, and especially Christian distinct from Catholic, are not found except among the foreign element. Therefore, Catholicism is the religion, not only of the majority, but of all the civilized Filipinos.

It is also certain that the Filipinos are sincere Catholics. Their religion suits them and is agreeable to them; they practice it voluntarily; they profess it without objection, openly and publicly. The most remote suspicion that Catholicism is not the true religion, and the only one capable of insuring temporal and eternal felicity, is far from their minds. All these Indians are in themselves docile to the teachings and admonitions of their parish priests and spiritual fathers; many good people readily and frequently partake of the holy sacraments, and that many others either do not come, or do not come so frequently, must be attributed to neglect, to carelessness, or to real impediments, but never to aversion. The ceremonies and the solemnity of the worship attract them extraordinarily, as do also the popular Catholic exhibitions of great feasts and processions. They show, without any objection, but rather with much pleasure, the pious objects and insignia of any pious devotion or association to which they belong, and in many places the women use the scapular or the rosary around their necks as a part or complement of their costume. It may be said that there is not a house or family, no matter how poor, which does not have an altar or domestic oratory. Among the Filipino people there may be careless, vicious Christians, and those scandalous for their bad habits, and even those ignorant of the essentials of their religion; but there are no unbelievers or impious ones, unless there are some, in number relatively insignificant, who have gone to foreign countries and become vicious, and have afterwards returned to the country; and even these have taken good care not to show it until now, because of a certain remnant of shame, unless among irreligious or sectarian companions. Finally, the three orders, confraternities, pious associations, and old and new devotions have always had in the Philippines a great number of inscribed, and even faithful and fervent, affiliated members.

The Catholic religion, always holy and sanctifying, works in its subjects who embrace it according to the natural or acquired disposition of the same. So that the defects of character of the Indians, although they are frequently lessened, thanks to the religion which they profess, hardly disappear wholly, and even influence the private life and religious character of the natives. Therefore, because they are more superficial and more impressed with novelties than other races, they perhaps might be less constant in their Catholic practices, sentiments, and convictions, and they would more readily than others feel the evil influences of false doctrines and worships if they should experience them. They are prone to superstition, on account of ancient bad habits, on account of the proximity and intercourse with those still infidels, and on account of their puerile imagination and their natural love of externals.

This we understand to be, in broad lines, the religious character of the Indians of the Philippines.

Now read what has been said recently on this same subject by another eye-witness, with whom we agree almost entirely.

Mr. Peyton, Protestant bishop, in a meeting of Protestant bishops of the Episcopal Church, held in St. Louis last October, said, speaking of Catholicism in the Philippines:

> I found in all the towns a magnificent church. I attended mass several times, and the churches were always full of natives, even under unfavorable circumstances, on account of the military occupation. There are almost no seats in these churches, the services lasting from an hour to an hour and a half. Never in my life have I observed more evident signs of deep devotion than those I witnessed there—the men kneeling or prostrated before the altar and the women on their knees or seated on the floor. Nobody left the church during the services nor spoke to anyone. There is no sectarian spirit there. All have been instructed in the creed, in prayer, in the ten commandments, and in the catechism. All have been baptized in infancy.[1] I do not know that there exists in the world a people as pure, as moral, and as devout as the Filipino people.

THIS GRANTED, WOULD FREEDOM OF RELIGIONS BE ADVISABLE IN THE PHILIPPINES?

Therefore, religion—and, consequently, morality—being so universal in the Philippines, would it be advisable to introduce liberty of religious worship in this country? If by freedom of religion is understood religious tolerance in fact, by virtue of which no one can be compelled to profess Catholicism, or be persecuted for not being a Catholic, but each individual may privately profess the religion which suits him best, then this liberty has always existed in the Philippines; and no Filipino or foreigner has ever been forced to embrace the Catholic

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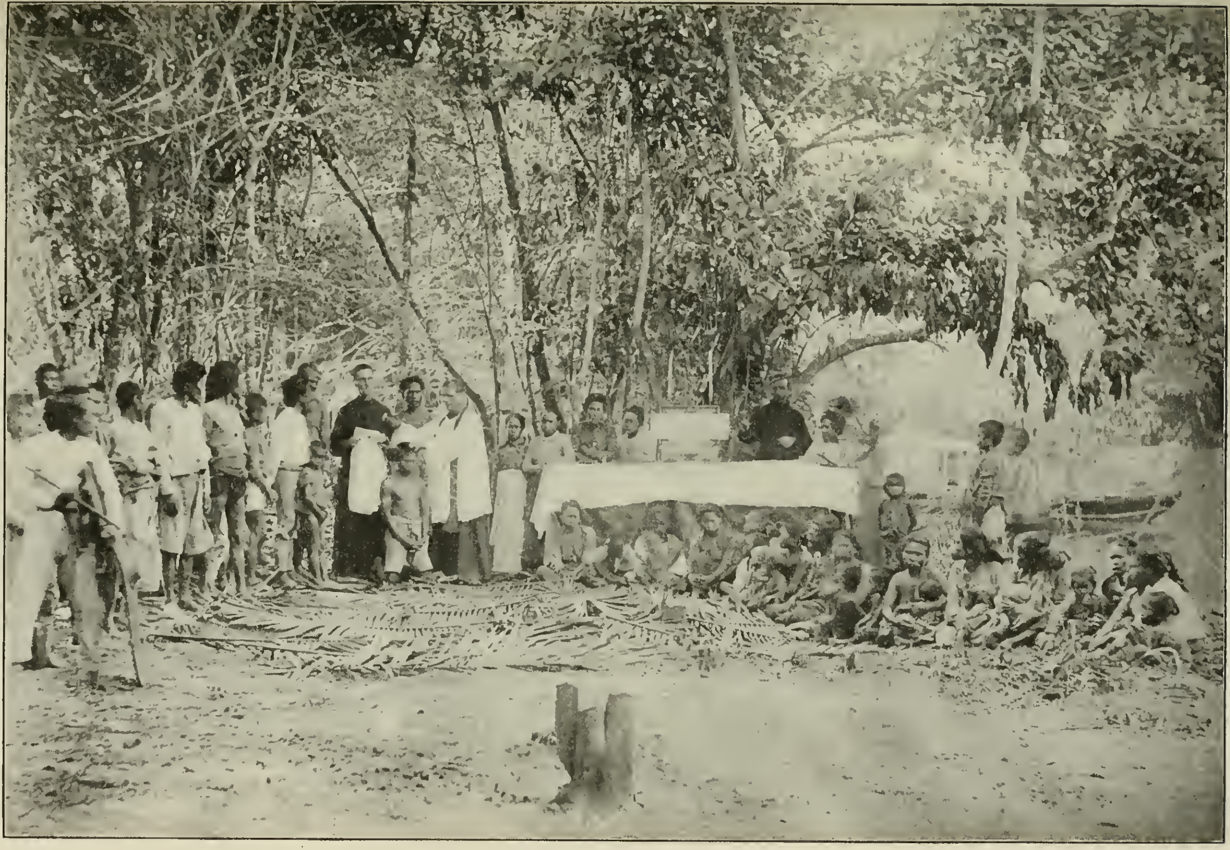
[1] It must be understood that this is outside of living missions, in more or less ancient Christian communities and towns.



THE BAPTISM OF FORTY-TWO MOROS.

religion. But if by liberty of religions is understood the granting to all religions—for example, the worship of Confucius, or of Mohammed—and to all the Protestant sects equal rights to open schools, erect churches, create parishes, have processions and public ceremonies, with the Catholic Church, we believe that it would not only not be advisable, but it would be a lamentable measure for any government which may rule the destinies of the Filipinos. In fact, if this Government should concede this liberty of religions, it will make itself hateful to 6,500,000 of Filipino Catholics; because, although said Government may not profess any religion, the Filipino people would hold it responsible for all the consequences of this measure, and so it could not be regarded favorably by these 6,500,000 Catholics. They are fully convinced that their religion is the only true one, the only one by which man can be saved; and if any government should try to deprive them of this religion, which is their most precious jewel and the richest inheritance that they have received from their superiors, although it may not be more than permitting Protestant or heterodox propagandism publicly and boldly, then they could not help complaining, and disturbance of public order might even result from it, with all the fury and all the disasters, which, as is well known, this kind of war usually entails.

Two serious difficulties may oppose the rights of Catholicism in the Philippines. The first is the Americans who are now governing here, and the second is the Filipinos themselves. The Americans enjoy in America the most complete religious liberty. Why, then, should they not enjoy the same liberty on moving to the Philippines? We answer that each citizen should conform to the laws of the country where he lives. The Chinese enjoyed the most complete liberty to erect temples to Buddha or to Confucius; but for three centuries they have not had such liberty in Manila. On the other hand, no Chinese has been obliged to become a Catholic; and, we may say more, no Chinese has needed to make a show of his religion in order to trade, become rich, and return to die in China. The same may be said of Englishmen and Americans. If, in the Philippines, for the good order and government of 6,500,000 Catholics, besides which there are only 1,500,000 inhabitants, idolaters and Mohammedans, who are still to be civilized, it is necessary not to permit nor to encourage liberty of religions, the government which rules the destinies of these islands should legislate in this direction, for the laws should be adapted to the necessities of the majority of the citizens. And Americans themselves who make their residence here should accommodate themselves to this law, without any temporal or spiritual injury resulting to them from it, because, privately, they could profess the religion which their conscience dictates to them to be the true one. The English in Malta do this, where the Catholic religion flourishes; and, although the island is very small, there are more than 2,000 Italian Catholic priests there, better satisfied and content to live under the English Government than under the Italian Government.

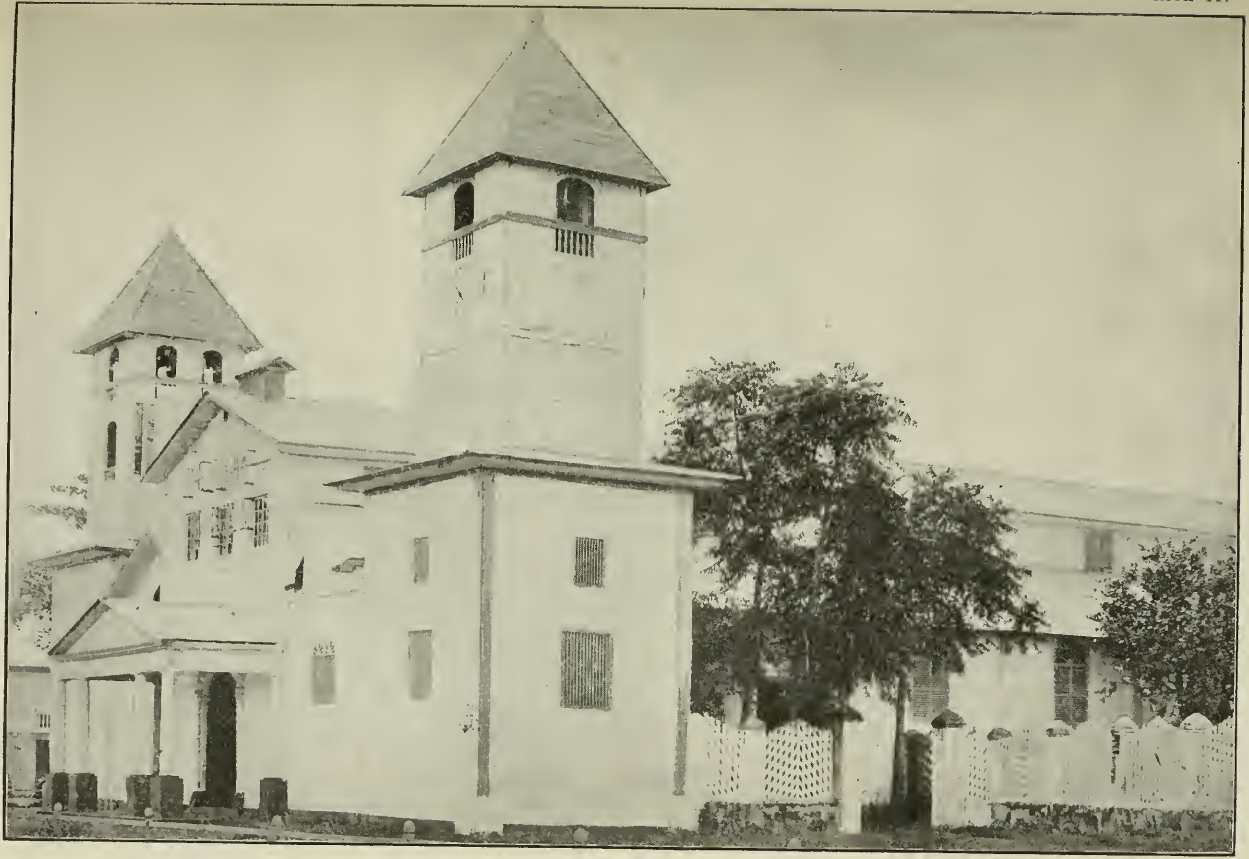
The other difficulty against the Catholicism of the Filipinos arises from the Filipino rebels themselves, who in their congress at Malolos proclaimed liberty of religions and separation of church and state. Why, then, should not this religious liberty be granted to the Filipinos if they themselves demand it? We answer that they also ask for independence. Will the Americans, therefore, give it to them?

The majority of the Philippine insurgents were addicted to Masonry. They had agreed a long time ago to work for the expulsion of the friars, and drunken with the wine of liberty they asked for all liberties, including religious freedom. These revolutionists, who have abjured Catholicism, how many are they? They do not exceed two dozen. For them the law of religious liberty is unnecessary, because they do not profess any. The Filipino people, that is to say, the 6,500,000 Catholics inscribed in the parochial registers—these do not ask for nor want religious liberty, nor the separation of the church and state; these are content with their Catholicism, and they do not desire anything more, nor would they suffer their government to overthrow the Catholic unity.

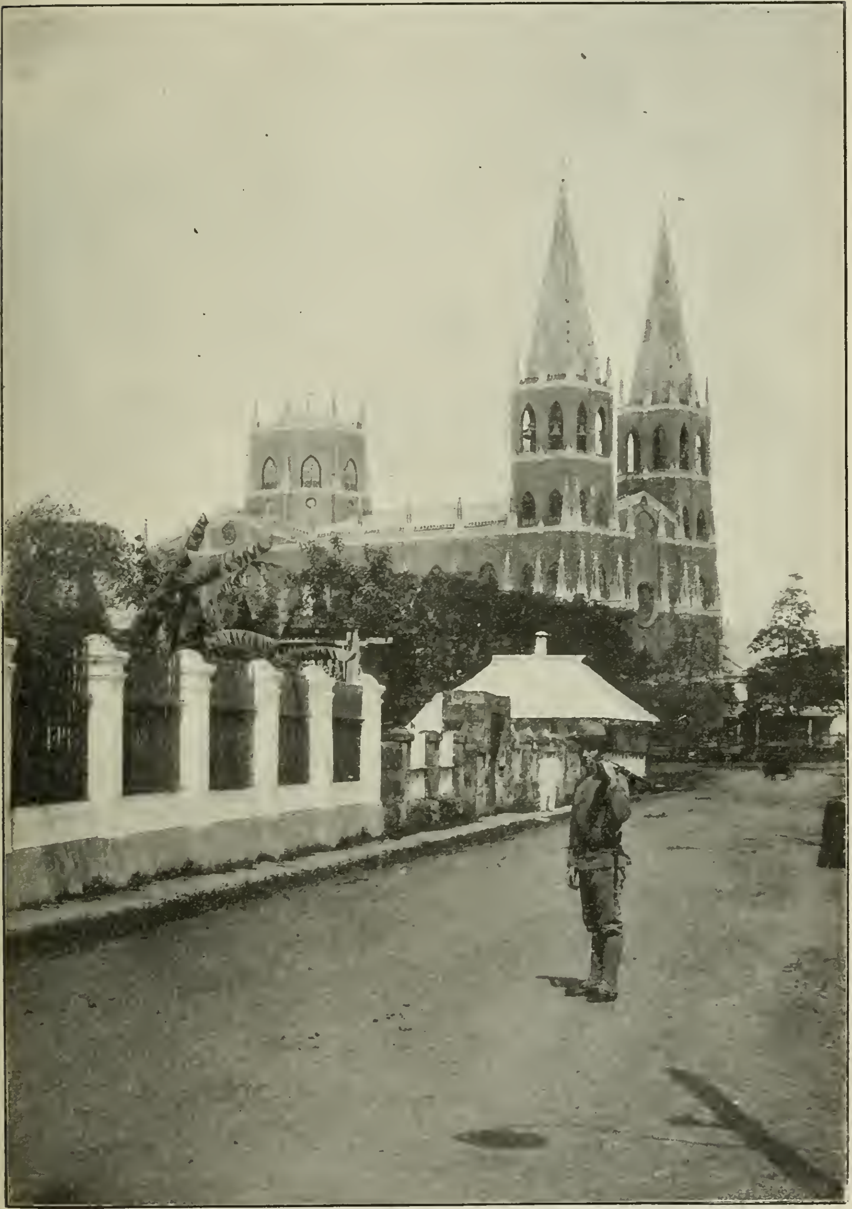
This we have heard from qualified and accredited defenders of Philippine independence, who even deny that the Malolos platform was the true expression of the will of that congress; that on the contrary it was far from being the total and proper representation of the Filipino people. This people have a horror of heresies and of all religious disturbances. Whoever should introduce them would commit an offense. Therefore it is demonstrated that religious liberty in the Philippines is not only not advisable but adverse to the public peace.

In conclusion, if it be said that as regards the state of religion in the Philippines there are points of public interest which demand some reform, we shall not deny it; but the church has the desire and the means to remedy these supposed or recognized evils. If by chance she does not remedy them because she is ignorant of them, then anyone interested may make them known, and the government of the country sooner than anybody else. On the other hand, this subject has nothing to do with religious liberty.

Plate X.

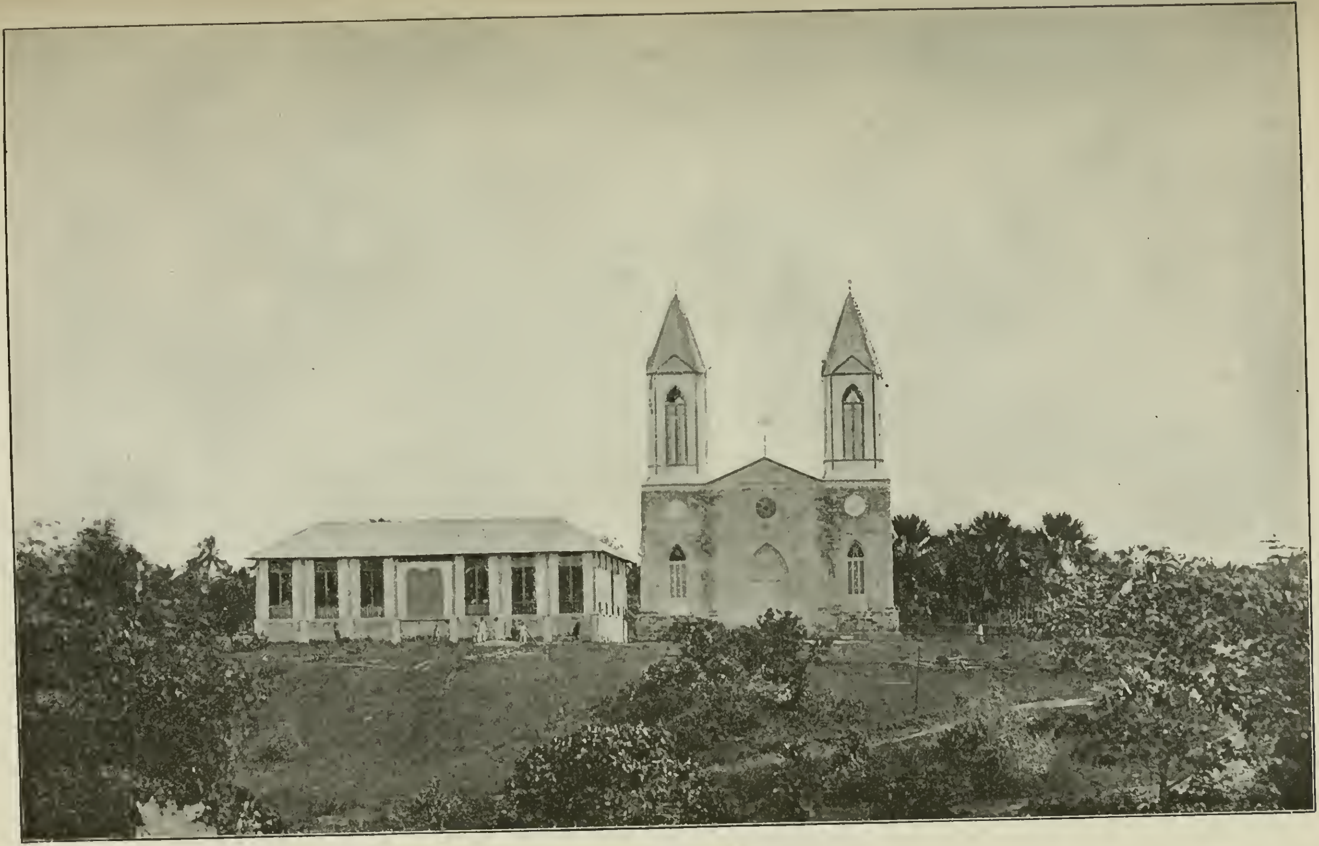


CHURCH OF ZAMBOANGA.



CHURCH OF SAN SEBASTIAN (MANILA).

PLATE XII.



CHURCH OF MERCEDES (ZAMBOANGA).

Built by the missionary and the people, 1893–94.

PLATE XIII.

CATHEDRAL OF MANILA.

PAPER NO. XXI.

CLIMATOLOGY.

CLIMATE AND METEOROLOGICAL FEATURES.

PROLOGUE.

The state of the weather and the different changes which it undergoes, due to the annual, daily, and hourly variations of the different meteorological elements (that is to say, to the temperature, atmospheric pressure, nebulosity, water precipitations, and the direction and force of the winds, etc.) constitute the climate of a country.

The importance and utility of a perfect climatic knowledge are well-known to all, as well as the methods generally adopted by meteorologists to obtain with ease most satisfactory results in this branch of meteorology. But referring in particular to the climate of these islands, it is to be said that the incidents which have developed in the last few years have excited most powerfully the anxiety of foreign nations, and especially of the United States, to more fully learn their climatic conditions, as is proved by the many requests made of this observatory, and which we have tried to acknowledge with the most copious meteorological data—data which at all times has been most acceptable, and is particularly so at the present time.

On this account the idea occurred to us to write a memoir or treatise on the "Climatology of the Philippine Archipelago." We could not help acknowledging its importance and the great opportuneness of the work, the more so since Spanish rule having ceased in these islands, it would serve to prove in the most evident manner the beneficial results obtained in this observatory after so many years of hard work, thanks to the protection given it by the Government of Spain, which in 1884 declared it an official institution of the State.

We could not help but see the grave obstacles that would be encountered in the consummation of this difficult task, which we had to complete in a limited period of time. Yet the motives which encouraged us in our work were so great and powerful that we decided, with the help of God, to undertake it, desirous of obtaining the best possible results from whatever data and observations were at our command. We have to acknowledge, however, that we had to do without many of them, and they may serve later for a more complete work on this subject.

The present work is divided into nine chapters. After a brief historical synopsis of the meteorological department of this observatory we give proper attention to atmospheric pressure, the temperature of the air, hygrometry, and aqueous precipitation, all of which comprise the first five chapters. We give the next two chapters to the discussion of the winds and atmospheric currents. In the eighth chapter we dwell on the most prominent or salient points of cyclones from the Far East, and we close the ninth chapter with some details of the hurricanes in Manila in recent years.

In addition to a large number of illustrations 112 tables accompany this treatise, in the compilation of which we have relied on skillful calculators attached to the observatory, all of whom, and especially Mr. Alejandro Amareta and Mr. Leopoldo Areopagita, are entitled to our gratitude for their activity and earnestness in helping us with the many calculations in the tables mentioned.

We hope that our humble work, though deficient and incomplete, will be well received by all those accustomed to the study of meteorology, not on account of the manner in which it has been done, but on account of the great importance the work itself embodies.

Observatory of Manila, *December 8, 1899.*

View 1.

OBSERVATORY OF MANILA.

General view.

CLIMATOLOGY.

CHAPTER I.

BRIEF HISTORICAL ACCOUNT OF THE METEOROLOGICAL DEPARTMENT, MANILA OBSERVATORY, 1865-1899.

I.—FOUNDATION AND EARLY PROGRESS OF THE METEOROLOGICAL DEPARTMENT, 1865–1884.

FOUNDATION.

The history of the meteorological department of the Manila Observatory dates from the foundation of the said observatory in 1865; for the only object which its founders had in the beginning, and especially Father Faura, was to devote himself to the study of meteorology, and to try to discover the laws governing the typhoons which so frequently visit these islands, in order to be able to give notice of them several days in advance, and prevent as much as possible their disastrous effects. The other departments—seismic, magnetic, and astronomic, which this observatory also now embraces and which are endowed with good collections of direct and registering apparatus—were created many years after. Their creation is due to the great development which the establishment was acquiring, patronized, as it was, first by private citizens, mainly mariners and merchants, residents of these islands, and afterwards by the Spanish Government itself, which gave it an official character. Thus it was provided with an adequate faculty and sufficient means to extend its sphere of action and place itself on the level of the best observatories in the Far East.

FIRST INSTRUMENTS AND PUBLICATIONS.

From 1865 to 1869, Father Faura did not have other means than a few absolutely necessary instruments for the observation of the principal meteorologic elements; instruments which were put at his disposal by the Ataneo Municipal, a school carried on by the fathers of the Society of Jesus, with which the observatory was connected until shortly after it was declared official.

Notwithstanding, in these first five years, they were able to publish a monthly sheet, and another annual report illustrated with various curves and lithographic figures, in which the results obtained in the observations of each month were given to the public, the measurements, monthly and annual, of atmospheric pressure, temperature, etc., and a short sketch of the principal atmospheric perturbations that occurred during the year.

ACQUISITION OF NEW METEOROLOGICAL APPARATUS—MONTHLY BULLETIN.

In 1870, the observatory, having acquired the universal meteorograph of Father Secchi, which gave its inventor such fame in the Exposition of Paris in 1867, began to publish regularly a monthly bulletin, which has been gradually perfected as the best means for carrying on these works, undertaken solely for the glory of God, the love of science, and the good of humanity. In addition to the large meteorograph, and at the expense of several private citizens, who regarded the work of the Jesuit Fathers with enthusiasm, this observatory obtained several other apparatus of direct observation, all of which had been previously corrected and compared with the normal instruments of the celebrated observatory of Montsouris.

FIRST ANNOUNCEMENTS OF TYPHOONS IN THE PHILIPPINES.

After some years of absence, during which various fathers, who were at the same time professors of the Ataneo Municipal, were at the head of the observatory, Father Faura returned to these islands as enthusiastic as ever for meteorology, and more so now that he had had an opportunity to visit the principal observatories of Europe. With the experience he had acquired during the first years of his residence in the Philippines he already saw not far distant the day when he could give notice in advance of the typhoons, and thus render incalculable service to all the inhabitants of these islands, and especially to maritime and commercial companies who, on different occasions, have given unequivocal proof of their gratitude.

In effect, Father Faura returned to Manila in August, 1878, and the following year he had the honor of being the first person in the Far East to predict the existence and duration and determine the probable course of the cyclones—known in the China Sea by the name of typhoons, and by that of baguios in the Philippines. The first announcement of a typhoon was given by him the 7th of July, 1879, indicating that its vortex would pass through the provinces of northern Luzón. The sad news of the destruction caused by the passage of the cyclone in the provinces of Isabela and Cagayán de Luzón soon confirmed the truth of that announcement.

The 18th of November of the same year Father Faura announced a second cyclone, this one to be feared in Manila itself. The alarm caused by such a prediction is indescribable. The captain of the port, Don Alejandro de Churruca, gave orders that no ship should leave port. The governor-general sent a messenger to Father Faura begging him to tell him what he had observed, which the father answered by simply confirming his announcement and adding that he thought it would be advisable to take precautions. Though there were those who contradicted these predictions, proper precautions were nevertheless taken, and, thanks to this, the damages were greatly lessened. The storm broke with force in the capital at midday, November 20. In the ports where for lack of telegraphic communication the notices could not arrive in time, the destructive effects of the hurricane were very great, 42 ships being lost in South Luzón and many persons killed.

We have stopped to give an account of this fact, because the accuracy of Father Faura in these first storm predictions was the chief reason why from that time on the announcements from this observatory have been regarded as worthy of consideration and have been held in great esteem.

FIRST NOTICES OF TYPHOONS SENT TO HONGKONG BY THE MANILA OBSERVATORY—NEW PUBLICATIONS—THE BAROMETER OF FATHER FAURA.

In the year 1880, as soon as the cable connected these islands with the neighboring colony of Hongkong, the requests from there by mariners and merchants for notices of typhoons from the observatory of Manila were so many that the government of the Philippines was obliged to accede to the petitions. Thus Father Faura soon saw with satisfaction that the fruit of his labors was being extended outside the archipelago. Stimulated by these results, he not only wrote several articles on storms, tracing the course of their trajectories, but in 1881 he published the well-known pamphlet entitled Precursory Storm Signals in the Philippines. He went on perfecting his barometer, now so celebrated and popular, intended to foretell the weather in the Philippines. In 1886 he offered it to the public and it has always been considered since that time by all who navigate these seas as the best guaranty of their safety.

II.—OFFICIAL APPOINTMENT AND SUBSEQUENT DEVELOPMENT OF THE METEOROLOGICAL DEPARTMENT, 1884-1899.

OFFICIAL APPOINTMENT.

The happy announcements of Father Faura suggested to many private citizens, to the press, and finally to the authorities of Manila the idea that the observatory of the Ateneo Municipal, which continued working as a private meteorological station, should be declared official and subsidized by the State and converted into a central station for a network of secondary stations, which should constitute the most complete meteorological service possible. To this end a committee was formed which, after several sessions (the minutes of which are in the archives of this observatory), decided to organize a meteorological service in all the archipelago, dependent in all respects on the observatory of the Ateneo Municipal, which in future should be called the Meteorological Observatory of Manila, and should be in charge of its first founders, the fathers of the Society of Jesus.

With this object a memorial was presented to His Majesty's Government in Madrid, which issued, on the 28th of April, 1884, a royal order by which the observatory was declared an official State institution, supported by it, and the meteorological service of the island of Luzon was created, the way being left open to extend it to the other islands when, in the course of time, they should be united by cable to the capital of the archipelago.

REMOVAL OF THE OBSERVATORY TO THE NEW BUILDING IT NOW OCCUPIES.

With this a new era for the Manila observatory began, which two years later was transferred to the magnificent building, surrounded with spacious gardens, which it now occupies, and where the different departments we mentioned in the beginning were soon organized. Limiting ourselves to the meteorological department, we shall briefly review here what has been accomplished in it from that time until the present year, 1899.

CREATION OF THE METEOROLOGICAL SERVICE OF LUZON.

The meteorological service granted by the Government of His Majesty was at once established in Luzon, fourteen substations being created, conveniently located in the center and on the eastern and western coasts of the island. All of them were supplied with a good set of meteorological apparatus and with "regulations and practical instruction," which were dictated by the director of the observatory for their good use and management. The daily observations taken in each one of these stations began to be published in the monthly bulletin of the observatory in the year 1885.

MUTUAL EXCHANGE OF OBSERVATIONS BETWEEN MANILA ARD JAPAN. ANNOUNCEMENTS OF TYPHOONS SENT TO THAT EMPIRE FROM THE OBSERVATORY OF MANILA.

In 1890, at the instance of his excellency the minister of foreign affairs of the Japanese Empire, a mutual exchange of observations was established between our observatory and the Central Observatory of Tokyo, to which were also sent after that time announcements of typhoons which, as we have already said, were sent to the coast of China from the year 1880.

THE OBSERVATORY TAKES PART IN THE METEOROLOGICAL CONGRESS OF THE CHICAGO EXPOSITION.

At the end of 1892 Father Miguel Saderra Mata, who was then director of the observatory of Manila, was officially invited to take part in the meteorological congress of the Chicago Exposition. This invitation being accepted, Fathers Faura and Algué were commissioned for this purpose at the expense and in representation of the Government of Spain. On their return from their scientific mission they published in Spanish, in proof of their gratitude to the Spanish nation, which they had had the honor of representing in that congress, an interesting memorial entitled Meteorology in the Columbian Exposition of Chicago. Father Miguel Saderra, who, on account of his office, could not attend the congress personally, contributed, however, a memorial on Whirlwinds in the Philippines.

THE OBSERVATORY COOPERATES IN THE INTERNATIONAL WORK OF MEASUREMENT OF CLOUDS, 1896–97.

Under date of May 6, 1895, an official communication was received from Mr. Robert H. Scott, secretary of the international meteorological committee, inviting the director of this observatory to cooperate in the international work of measuring clouds for a period of one whole year, beginning May 1, 1896.[1]

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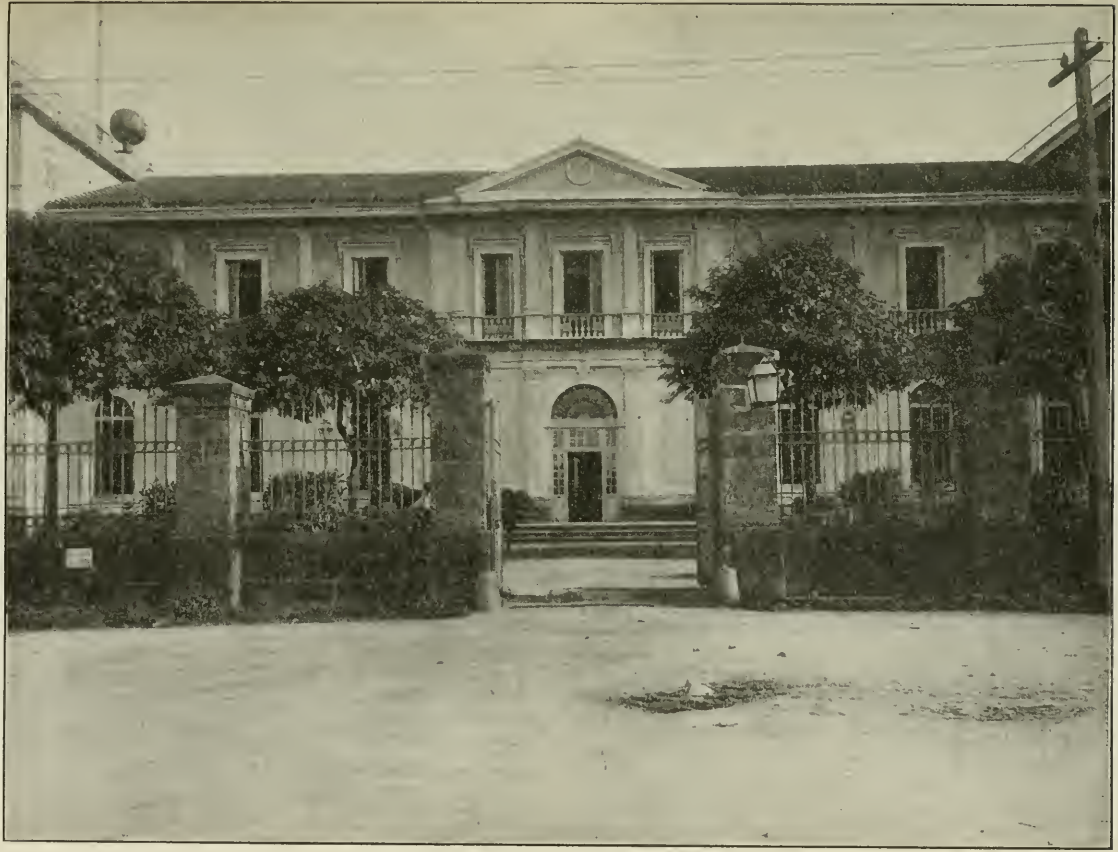
[1] Later the period of observation was prolonged till August 1, 1897.

View II.



ENTRANCE OF THE MANILA OBSERVATORY.

The invitation was accepted, and in consequence the observatory of Manila is the only one in the Far East which can be counted among the sixteen central observatories of different nations which took part in a scientific enterprise of such interest for the study of meteorology.

Without loss of time Mr. O. Gunther was ordered to construct two phototheodolites exactly like those constructed by the same man for the Central Observatory of Germany, Potsdam, which could not possibly reach Manila before the end of May, 1896.

The photographic observations began with regularity on the 1st of June of said year, under the direction of Father José Algué, then subdirector and now director of the observatory, who published last year the result of his investigations in a valuable work which has for its title "The Clouds in the Philippine Archipelago. Collaboration of the International Work of Cloud Measurement. June 1, 1896, to July 31, 1897."[1]

PUBLICATION OF THE WORK "BAGUIOS," OR PHILIPPINE CYCLONES. FATHER ALGUÉ'S BAROCYCLONOMETER.

In the year 1897 the same Father Algué published the well-written work "Baguios," or "Philippine Cyclones," so coveted by mariners, and which is at present being translated into several languages. At the same time he offered to the public his "barocyclonometer," a perfection of the barometer of Father Faura, intended to foretell typhoons, not only in the Philippines, but in all the extreme Orient.

THE METEOROLOGIC SERVICE OF THE OBSERVATORY OF MANILA VINDICATED AND REHABILITATED IN 1899.

The announcements of typhoons of the Manila observatory have always been held in great esteem, not only in the time of the never-to-be-forgotten Father Faura, but also up to the present time, as innumerable facts confirm it. We shall only cite one, which is worth a thousand.

At the end of 1898 the director of the British meteorological service at Hongkong, taking advantage of the favorable opportunity offered by the serious circumstances through which these islands were passing, addressed himself to the Agricultural Department of the Government of the United States of America in terms very unfavorable to the directors of the Manila observatory, calling the attention of said Government especially to the scandalous alarm which, according to him, the alarming predictions of typhoons sent out by this observatory and published in the newspapers of the neighboring colony frequently caused. The immediate effect of this accusation was the order given by the Secretary of War of the United States that from that time all notices of typhoons sent by telegraph from Manila to points outside of the Philippine Archipelago should be suspended.

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[1] Mr. H. H. Hildebrandsson said of it, in a letter written to Father José Algué, dated June 19, 1899, for the purpose of thanking him for a copy which he had just received: "Your publication regarding cloud observations in the period from 1896 to 1897 is the first that has appeared up to date complete. I beg you to send me another copy that I may present to the international committee, which is to meet in St. Petersburg on the 2d of next September."

In another later letter, of September 22, the same Mr. Hildebrandsson added: "Your publication on clouds was received with admiration and the liveliest enthusiasm on the part of all the members of the international commission assembled in St. Petersburg, especially taking into account the stupendous difficulties in the midst of which you carried out a work of such importance."

The indignation which this act caused in the press of Manila and Hongkong, in marine circles and mercantile communities, and in general in all the inhabitants of the Far East, the curious reader may see in a collection of documents entitled "The meteorological service of the Manila observatory vindicated and rehabilitated," which was published in Manila about the middle of the present year (1899).

The Chamber of Commerce of Hongkong protested vigorously before the colonial government against the suspension of the announcements of typhoons from Manila, so contrary to the maritime and commercial interests of the Far East, in view of which the government of Hongkong addressed an official communication to the military governor of the Philippine Islands requesting the revocation of the order prohibiting the announcements of typhoons, as the director of the Hongkong observatory had not been authorized in any way for the request made on his own responsibility to the Secretary of Agriculture of the United States, against the will of his own government and contrary to the welfare of the colony.

The governor-general of the Philippines granted the petition of the colonial governor of Hongkong, and under date of April 3 the director of this observatory received an official communication in which said order was revoked and he was told to continue sending out from the islands his notices of typhoons which were so much desired in Hongkong.

In this way, thanks to the unanimous testimony of public opinion and especially to the attitude taken by the Chamber of Commerce of Hongkong, the meteorological department of the Manila observatory was reinstated in the esteem of the Government of the United States, which has begun to support this institution, recognizing the same official character which the Spanish Government gave it in 1884.

III.—APPARATUS OF THE METEOROLOGICAL DEPARTMENT OF THE MANILA OBSERVATORY.

It is not our intention, nor is it proper in this place, to describe any of the valuable instruments which the meteorological department of this observatory now has. We suppose that they are known to our readers, and we shall only give here a list or catalogue of the same, so that an exact idea may be had of how well equipped and furnished is this section, which on account of its nature is the first and most important one of the observatory.

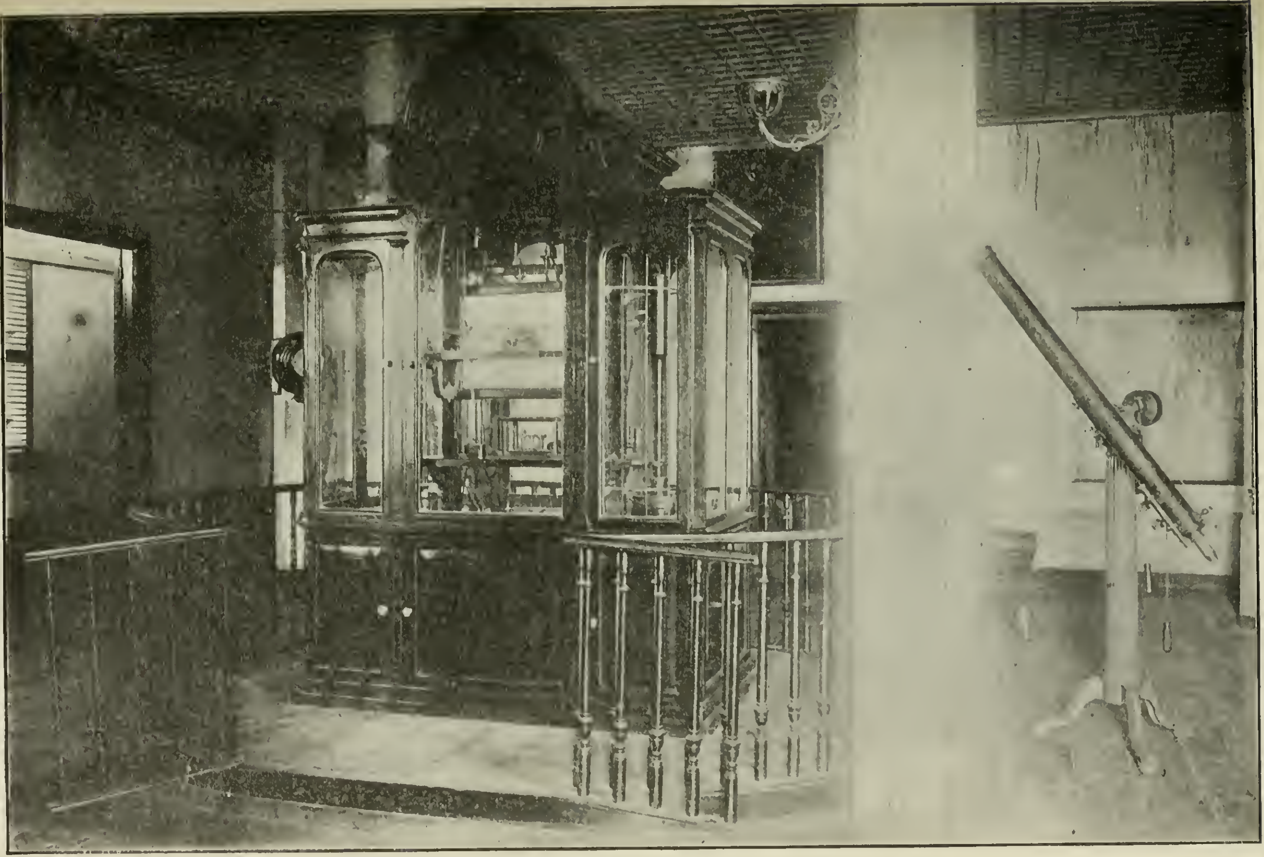
APPARATUS OF DIRECT OBSERVATION.

Two large standard barometers, one of the Fortín system, made by Casella; the other with a fixed bulb and movable scale, made by Negretti & Zambra. Both were tested in the observatory of Kew. The tube measures 17.5 mm. interior diameter.

Other mercurial barometers, Fortín and Tormelot, for ordinary use. Several aneroid barometers of Father Faura and barocyclonometers of Father Algué.

One standard thermometer, made in France, with a scale divided into tenths of a degree.

VIEW III.



THE SECCHI METEOROGRAPH OF THE MANILA OBSERVATORY.

Another thermometer, also standard, Kuchler.

Standard thermometers, maximum and minimum, from Fuess (Berlin).

Various other simple maximum and minimum thermometers from Negretti & Zambra.

One standard Fuess psychrometer.

One hygrometer of condensation, Regnault.

One photopolarimeter, M. A. Cornu.

One thermohygroscope and weather telegraph (Lambrecht) to announce storms and changes of weather.

One psychrometrograph of aspiration, Lambrecht.

One Lambrecht polymeter to observe the temperature, humidity, and tension of vapor.

Several Robinson anemometers and weathercocks.

Two traveling anemometers, Fuess and Richard.

One Weld anemometer.

One nephoscope of Father Cecchi.

Two Fineman nephoscopes.

Two French photogrameters made by Charles Echassoux, machinist of Teisserene de Bort, secretary of the Central Meteorological Bureau of France; and two others, German, made by D. Gunther, of Brunswick, exactly like those made by him for the Central Observatory of Germany at Potsdam. These instruments were obtained by the Observatory of Manila to contribute to the great international undertaking of the determination of the general movements of the atmosphere in all the globe, taking as a basis the exact measurements of the height, velocity, and direction of the clouds.

Two pluviometers, Symonds and Grosley, and others of different systems.

Several Piche vaporimeters.

One ozonometer of James Clarke.

One actinometer of Arago.

One hygienic-meteorologic observatory.

A shelter for the thermometers and hygrometers (Montsouris system).

A shelter for the thermometers and hygrometers (Fuess system).

Aspirating pump to compare aneroids.

REGISTERING APPARATUS.

Father Cecchi's universal meteorograph, which has been in use in the observatory of Manila since 1869.

One barograph, Sprung-Fuess.

Several Richard barographs, of large size, type adopted for the secondary stations established in Luzón.

Several thermographs, Richard.

Two Richard terrestrial thermographs.

Several Richard psychrographs.

One Richard hygrometrograph.

One Richard anemoscope-anemograph, which transmits electrically the velocity of the wind and mechanically its direction.

One Beckley anemograph, made by Negretti & Zambra.

One Garrigon-Lagrange dyno-anemograph.

One Richard pluviograph.

One Casella pluviograph.

One Whipple-Casella universal heliograph.

One Richard heliograph.

One Thompson electrometer, modified by M. Mascart, with photographic register in order to observe atmospheric electricity.

Two stations in the open air with registering apparatus.

INSTALLATION OF THESE APPARATUS.

Before concluding this paragraph we shall say a few words about the installation of these instruments and the observations made daily in our department. There are three buildings built in the same inclosure for the uses of the observatory—the main one, partly occupied by the Superior Normal School for Teachers, and two others devoted exclusively to the magnetic and astronomical sections. The meteorological apparatus that do not require to be in the open air are distributed in two large rooms in the main building. On the roof of the right tower of the same edifice, about 18 meters above sea level, we have suitably placed the apparatus for the open air and for the shade. For the latter we make use of ordinary shelters of double blinds, a system of covering which, considering the locality where they are placed, has given us better results than the double covering used in the observatories of Montsouris and of the park of San Mauro. Notwithstanding, at a short distance from the ground and in the park there has also been built a shelter agreeing in all respects with that used in the park of San Mauro in Paris, but the observations made in it have up to the present time been very few, so that in studying the climate of Manila we can only make use of those taken in the plant above mentioned.

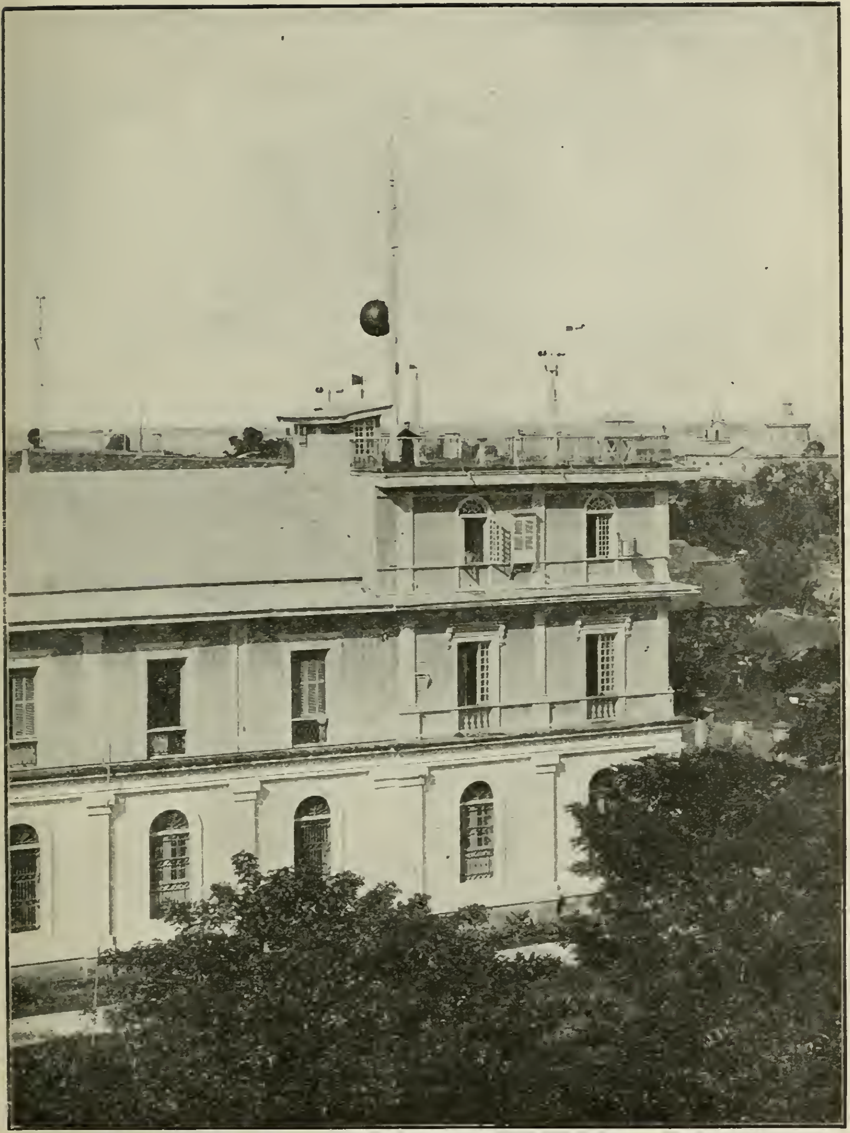
SERIES OF METEOROLOGICAL OBSERVATIONS MADE IN THE OBSERVATORY FROM 1865 TO 1899.

From 1865 to 1880 only six daily observations were taken. In 1880 they began taking hourly observations from 5 in the morning until 11 at night, and from 1883 to the present time they have also been making hourly observations during the night. At first these observations were made each hour with the direct apparatus, but at present, when the observatory is well provided with registering apparatus which is perfectly accurate, they take from them the hourly data during the night, and continue taking direct observations during the day from 5 a. m. to 9 p. m. They began publishing the hourly observations in the monthly bulletin in 1890.

IV.—SERVICES WHICH THE METEOROLOGICAL DEPARTMENT OF THE MANILA OBSERVATORY RENDERS TO THE PUBLIC, AND ESPECIALLY TO MARINERS.

ORDINARY REPORTS OF WEATHER, MAXIMUM AND MINIMUM TEMPERATURE OF EACH DAY, DAILY TELEGRAMS OF OBSERVATIONS TO THE CAPTAIN OF THE PORT AND THE CHIEFS OF THE SQUADRON AND TO THE COASTS OF CHINA AND JAPAN.

In the meteorological department of the Central Observatory of Manila, besides the constant and assiduous work of the direct observations which are made hour after hour, of the mean values deducted from these observations, and which are published in the monthly bulletin, of the studies of the state of the atmosphere and atmospheric perturbations, which may be seen in the same bulletin, etc., even in



DEPARTMENT OF SEISMOLOGY AND TOWER OF METEOROLOGICAL APPARATUS.
Manila Observatory.

normal weather important services are rendered to the public, which it would not be fair to pass by in silence.

There are received daily the meteorological registries from the coasts of China and Japan and from the secondary stations of Luzón (when this meteorological service of the island is working regularly, as was the case before the present state of things). Having studied all these observations carefully, the report of the probable weather during the next twenty-four hours is given; a report which is published in the newspapers of the capital and transmitted telegraphically to the captain of the port of Manila, to the chiefs of the squadron and of the naval station at Cavite. Besides, and also daily, the maximum and minimum temperature for each day is sent to the newspapers. To the captain of the port of Manila, as well as to the abovementioned chiefs, there is a report made by telegraph twice a day—that is, at 10 a. m. and 4 p. m.—of the observations made in the observatory of atmospheric pressure, temperature, direction and force of the wind, and state of the weather. Likewise, at 10 a. m. and 4 p. m. the same observations are transmitted to the most important stations on the coasts of China and Japan.

EXTRAORDINARY REPORTS, ANNOUNCEMENTS, AND ADVICES WHICH THE OBSERVATORY ISSUES ON NOTING THE FIRST INDICATIONS OF THE PROXIMITY OF A TYPHOON.

In times of any atmospheric disturbance, more or less near, the work and the vigilance of the directors of the observatory is multiplied. As soon as the first indications of a storm are noted observations are taken more frequently, especially of the direction of the different classes of clouds, and observations are more frequently asked for from those secondary stations likely to feel its influence most, and, if necessary, every hour, and they advise the public of Manila, the captain of the port, the authorities, and all who ask the observatory about the state of the weather, especially the firms controlling the ships anchored in the bay, of the existence of the storm. As soon as it is possible to determine the time of the typhoon and its approximate course the captain of the port is notified to hoist the appropriate signal.

If the typhoon is not imminent nor very dangerous for the capital, the observatory limits itself to indicating the course of the same in the weather reports it gives to the public, to the authorities, and to the captain of the port, but not without giving due notice to the provinces of Luzón that are threatened, so that they may be prepared for the storm. If the typhoon is likely to be dangerous for the place, then the number of observations is considerably increased, and even through all the night advices are given to the public and to the authorities, more or less urgent, as the case requires, and especially a detailed account of the danger is given to the chiefs of the squadron and to the captain of the port; in a word, all those measures and precautions that may seem best are taken to prevent misfortunes as much as possible.

Besides, the observatory not only fulfills its obligations toward the public in general and the authorities of Manila, but it is also accustomed to give due notice to shipping firms that have advertised the sailing of any ship, so that they may either detain it, if they think it necessary, or, in case it sails, that the captain may be forewarned, and, realizing the danger, may take the necessary steps to escape from it.

IMPORTANCE OF THE TYPHOON NOTICES WHICH THE OBSERVATORY SENDS OUT TO THE PRINCIPAL STATIONS ON THE COASTS OF CHINA, COCHIN CHINA, AND JAPAN.

But the services rendered by the Manila observatory are not confined to Manila nor to the Philippine Archipelago. In fact, telegrams are often received from captains of ships anchored in the different ports of the archipelago, or even also in Singapore or in Hongkong, asking the opinion of our observatory in regard to the weather, whether or not there is any danger of encountering a typhoon in the passage they have to make from that port to Manila—telegrams which the Manila observatory always answers as promptly and as accurately as possible. Outside of this, there is no reason why we should praise here the services rendered by this observatory to mariners and merchants and to the general public by the announcements of storms which it issues to Hongkong, Macao, Saigón, Shanghai, and Tokyo. The position occupied by the Manila observatory makes it an outpost whence the coasts of Asia and Japan can be advised in due time of the existence and course of the typhoons. The storms which, passing through our latitudes more or less near to Manila, cross the China Sea, do not reach the Asiatic coast for two, three, or even more days, as the experience of many years teaches us; and those which we experience in eastern Luzón, and which travel in the direction of Japan, take from three to ten, and even more, days in crossing. This clearly demonstrates the utility of our observations and advices of storms to the continent of Asia, the Empire of Japan, and to all the foreigners who navigate these seas. The governments of the colonies of Hongkong, Saigón, Macao, and Shanghai, and that of Japan understood this when they asked with so much interest for telegraphic advices of typhoons from the Manila observatory.

AVERAGE NUMBER OF TELEGRAMS SENT OUT DURING EACH TYPHOON—EAGERNESS WITH WHICH THESE TYPHOON NOTICES FROM THE MANILA OBSERVATORY ARE RECEIVED IN HONGKONG.

These telegrams are usually three for each typhoon—one when the first symptoms are noted, announcing its existence and its delay; another when it passes at the minimum distance from the archipelago or crosses the islands, already indicating, not only the delay, but, if possible, the direction of the meteor; and another final one when it leaves the archipelago, either by the China Sea or by the Pacific, in the direction of Japan. The eagerness with which these telegrams are received in the neighboring colony of Hongkong is known to all who reside there, and is confirmed by two recent events.

COMPLAINT MADE TO ADMIRAL DEWEY BY A HIGH OFFICIAL OF THE BRITISH FLEET AT HONGKONG ON ACCOUNT OF THE INTERRUPTION OF THESE TYPHOON NOTICES FROM MANILA ON ACCOUNT OF THE BREAK IN THE CABLE IN THE FIRST PART OF MAY, 1898.

The first was the communication which, shortly after the breaking of the cable connecting Manila with Hongkong, a high officer of the Royal British fleet at Hongkong addressed to Admiral Dewey, requesting him to reestablish the cable if he did not wish to make himself responsible for the loss of life and property which would doubtless result from the lack of telegraphic advices of typhoons from the Manila observatory.

THE CONSUL-GENERAL OF THE UNITED STATES IN HONGKONG ASKS THAT THE TYPHOON NOTICES FROM MANILA BE SENT DIRECTLY TO HIM.

The second is the petition made to the Manila Observatory by Mr. Rounsevelle Wildman, consul-general of the United States in that colony, when the cable was reestablished, that our telegrams should be sent directly to him, as they had formerly been sent to the Spanish consul when Manila was under the Spanish dominion.

SERVICES RENDERED BY THE OBSERVATORY BY THE REGULATION AND COMPARISON OF ALL SORTS OF BAROMETERS AND BAROGRAPHS.

We shall conclude this paragraph by briefly mentioning another of the services rendered gratis to the public, and especially to mariners, by the meteorological department of the Manila Observatory, and that is the comparison, and even repairing in many cases, of all kinds of barometers and barographs. Here the worth of these instruments is tested, their working is observed, and they are compared with the standard ones in the observatory, and, if it is thought necessary, a report is given of the instrumental error of the apparatus.

CHAPTER II.

ATMOSPHERIC PRESSURE.

INTRODUCTION.

As a preamble to what we shall have to say in this and in the subsequent chapters we shall mention here two things: First, that on account of lack of time at our disposal for this work, which is in itself arduous and difficult, we have only used the hourly observations taken without interruption from 1883 up to last year, 1898, inclusive. Those taken in this observatory previous to 1883 were not hourly, and so, partly for this reason and also partly because of some deficiencies which we found in the trihourly observations and in the monthly averages deducted from them, we could not make use of them without making some corrections in order to make them uniform and comparable with the hourly ones of said period from 1883 to 1898, which required more time and less haste on our part. Second, that even when the monthly mean values of the four meteorological elements which we shall soon study, namely, atmospheric pressure, temperature of the air, relative humidity, and tension of aqueous vapor, have been deducted from this period of sixteen years, notwithstanding, we deduct the mean daily variation from a somewhat shorter period, for the reason which we are going to indicate. We have already said in the last chapter that, although hourly observations began to be made in this observatory in 1883, still these were not published in our bulletin until 1890; hence those for the earlier years are not only unpublished, but not even arranged so that the hourly means for each month could be easily found. With this brief explanation, those persons versed in this kind of study will understand the laborious work involved in putting so much material in order, and, after arranging it, deducting the hourly averages for each one of the seven years from 1883 to 1889—a work which we would have been glad to undertake if the time in which we prepared this memorial had not been so limited. Hence for the daily variation of the barometer we have taken the period from 1887 to 1898 (twelve years); for the variation, also daily, of the temperature of the air, the period from 1889 to 1898 (ten years), and the period from 1890 to 1898 (nine years) for the daily variation of the relative humidity and tension of aqueous vapor. In view of the regularity with which, here in the Tropics, the variations and oscillations of these meteorologic elements are repeated every year, we believe that the results obtained with these periods will give us mean values sufficiently exact and precise, although we must confess that they will be still more accurate when, having more time, a greater number of years of observation is included in this study.

I.—ANNUAL VARIATION OF ATMOSPHERIC PRESSURE IN MANILA.

The annual variation of atmospheric pressure in Manila may be seen in Table I. From the monthly averages as they appear on the last line of the table between years 1883 and 1898 has been plotted the curve, Plate I.

TABLE I.—*Monthly and annual averages of atmospheric pressure in Manila during the period from 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1883...	760.82	61.47	60.62	59.31	58.34	58.43	57.25	57.77	58.09	59.53	59.74	62.52	59.49
1884...	763.23	62.91	60.89	60.75	58.93	58.70	56.62	57.68	57.91	60.12	59.92	61.70	59.95
1885...	763.60	62.10	62.39	60.34	59.89	58.49	58.50	57.52	59.57	60.28	61.39	61.79	60.49
1886...	761.61	62.46	61.73	59.80	59.04	58.76	58.61	58.44	58.15	59.36	59.65	60.48	59.84
1887...	760.54	61.06	60.14	59.27	58.44	58.23	57.58	58.45	56.66	59.51	59.70	60.71	59.19
1888...	761.76	62.25	61.26	59.84	58.59	57.54	56.00	57.84	57.90	60.06	60.52	60.96	59.54
1889...	761.99	61.75	62.03	59.80	59.09	58.74	57.75	58.20	58.37	58.28	58.17	58.90	59.42
1890...	759.68	60.70	59.74	59.26	58.43	58.32	58.05	58.18	56.24	57.76	60.08	61.03	58.96
1891...	760.37	62.57	60.96	60.06	58.76	57.65	56.50	57.70	58.11	59.34	58.97	61.75	59.40
1892...	760.93	60.48	59.45	59.50	58.62	57.72	57.53	58.61	57.03	57.63	58.63	60.70	58.90
1893...	760.66	61.10	60.98	59.35	57.47	58.96	57.57	57.41	56.56	58.48	59.76	60.45	59.06
1894...	760.23	61.96	59.97	59.19	57.89	57.83	57.78	57.58	56.53	58.35	59.45	60.67	58.95
1895...	760.65	61.42	60.20	59.39	57.81	57.48	57.92	56.85	56.41	58.68	60.37	60.96	59.01
1896...	761.79	61.73	60.24	58.97	58.00	57.97	56.66	56.99	58.29	58.65	60.39	62.34	59.33
1897...	761.44	61.13	60.71	59.43	58.41	57.41	58.36	57.82	57.91	58.56	58.75	60.30	59.19
1898...	760.97	59.26	58.30	58.88	57.74	57.04	57.36	56.93	58.23	57.52	57.26	59.40	58.24
Mean.	761.27	61.52	60.60	59.57	58.47	58.08	57.50	57.75	57.62	58.88	59.55	60.92	59.31

RELATION BETWEEN THE NORMAL AVERAGES OF THE DIFFERENT MONTHS OF THE YEAR.

From simply looking at this curve, we deduce that the barometer reaches its greatest mean height in the month of February. It descends at almost the rate of 1 mm. a month from February to March, from March to April, and from April to May. It continues its descent, although not so noticeably, from May to July, when the lowest average of the whole year is reached. A slight rise is noted in August, after which it again descends a little in September, although the mean height for this month is somewhat greater than that of July. Finally, the monthly average increases without interruption from October to February, the ascents which are observed from September to October and from November to December being very remarkable.

ANNUAL MEAN OSCILLATION OF THE BAROMETER.

The mean annual oscillation of the barometer, or the difference between the maximum monthly average, which is, as has been said, that of February, and the minimum, or that of July, is 4.02 mm.

THE NORMAL AVERAGES OF EACH MONTH COMPARED WITH THE NORMAL ANNUAL AVERAGE.

The annual average is 759.31 mm. The degree to which the different monthly averages differ more or less from this annual mean is indicated in the following table:

Month.	Monthly mean.	Difference.
	Millimeters.	*Millimeters.*
January	761.27	+1.96
February	761.52	+2.21
March	760.60	+1.29
April	759.57	+0.26
May	758.47	−0.84
June	758.08	−1.23
July	757.50	−1.81
August	757.75	−1.56
September	757.62	−1.69
October	758.88	−0.43
November	759.55	+0.24
December	760.92	+1.61
Annual mean	759.31	

EXTREME ANNUAL AVERAGES.

The extreme annual averages of the period we are considering are 760.49 mm. (1885) and 758.24 mm. (1898), only differing by 2.25 mm.

COMPARISON BETWEEN THE NORMAL AND EXTREME AVERAGES OF EACH MONTH.

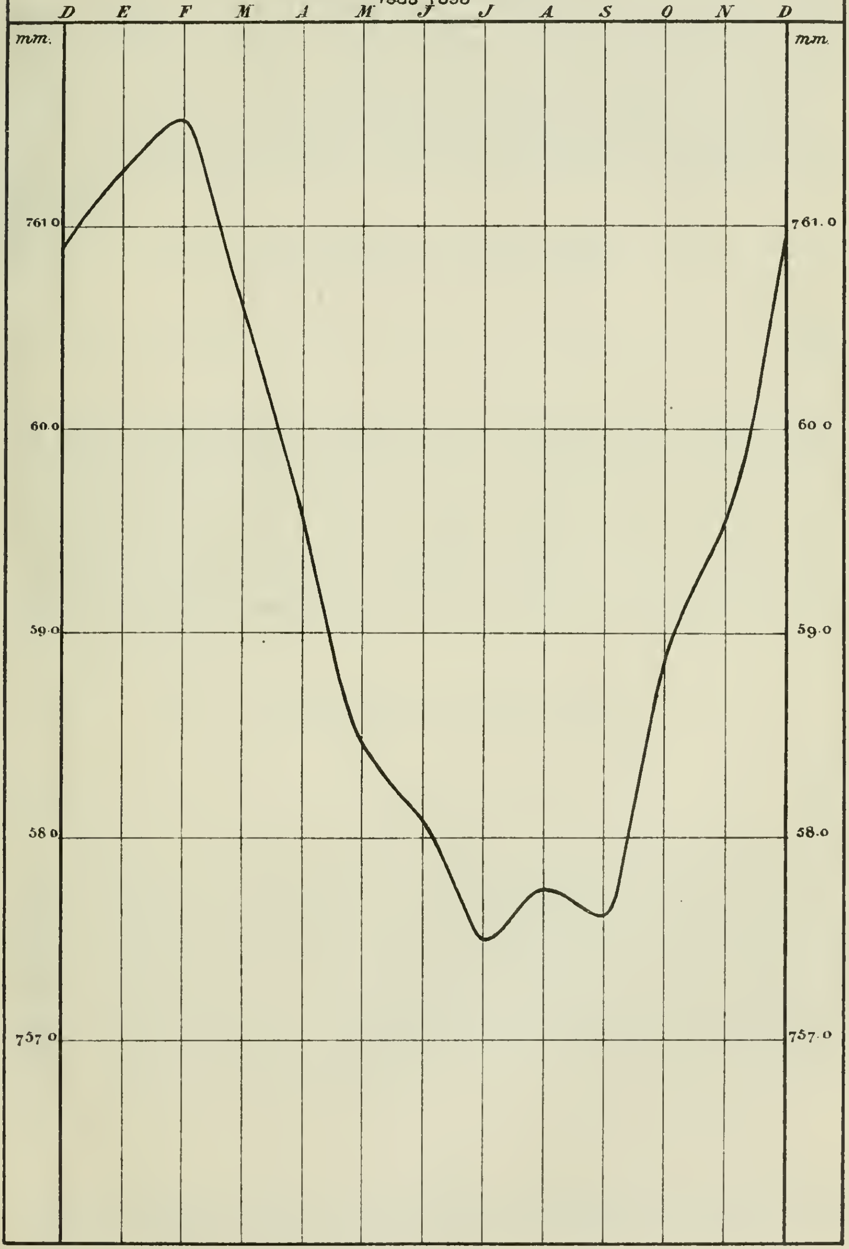
In the following table we give the difference between the normal monthly averages and the extreme averages of each month:

Months.	Monthly mean.	Maximum positive difference.	Maximum negative difference.
	mm.	*mm.*	*mm.*
January	761.27	2.33 (1885)	1.59 (1890)
February	761.52	1.39 (1884)	2.26 (1898)
March	760.60	1.79 (1885)	2.30 (1898)
April	759.57	1.18 (1884)	.69 (1898)
May	758.47	1.42 (1885)	1.00 (1893)
June	758.08	.88 (1893)	1.04 (1898)
July	757.50	1.11 (1886)	1.50 (1888)
August	757.75	.86 (1892)	.90 (1895)
September	757.62	1.95 (1885)	1.38 (1890)
October	758.88	1.40 (1885)	1.36 (1898)
November	759.55	1.84 (1885)	2.29 (1898)
December	760.92	1.60 (1883)	2.02 (1889)

The maximum positive difference was 2.33 mm., observed in the month of January, 1885; and the maximum negative difference corresponding to March, 1898, was 2.30 mm. The minimum positive and negative differences, 0.86 mm. and 0.69 mm., belong to the months of August, 1892, and April, 1898, respectively.

ANNUAL VARIATION OF THE ATMOSPHERIC PRESSURE AT MANILA

1883-1898



II.—MONTHLY ABSOLUTE MAXIMA AND MINIMA OF ATMOSPHERIC PRESSURE IN MANILA.

Desiring to present here in two tables the monthly absolute maxima and minima observed in this observatory, we decided to begin with the year 1887, because, having installed the previous year the Sprung-Fuess barograph, it was only from that time that they began to take these absolute maxima and minima from the curves registered by said apparatus. The extreme values which this observatory published before that were not, properly speaking, absolute maxima and minima, but the maxima and minima of the twenty-four daily observations.

Tables II and III therefore include, respectively, the monthly absolute maxima and minima for a period of twelve years—from 1887 to 1898.

Table II.—*Monthly and annual absolute maxima of atmospheric pressure in Manila during the period from 1887 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual maximum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887...	763.70	65.64	63.29	62.63	61.57	61.54	61.12	61.43	61.79	62.80	63.23	63.07	65.64
1888...	765.39	66.55	64.20	62.62	61.97	60.88	59.99	62.62	61.37	63.43	64.00	65.23	66.55
1889...	764.45	65.03	65.64	62.83	62.40	61.40	61.14	62.46	62.59	62.60	62.97	63.56	65.64
1890...	764.54	64.29	63.74	62.81	60.98	61.00	61.78	61.10	59.54	62.73	64.51	63.78	64.54
1891...	764.35	66.78	64.39	63.07	62.41	60.55	60.45	61.45	62.32	63.20	63.70	65.09	66.78
1892...	765.06	63.70	62.98	62.92	61.09	61.22	60.71	61.60	62.03	62.15	62.22	64.14	65.06
1893...	765.18	65.21	65.72	63.52	61.60	62.01	60.27	61.35	61.76	62.67	62.99	64.05	65.72
1894...	763.47	65.18	64.70	62.43	61.09	61.07	60.78	60.31	61.95	61.35	63.81	66.00	66.00
1895...	764.05	64.74	64.34	63.33	61.16	60.44	61.60	60.42	61.02	61.17	64.43	64.81	64.81
1896...	765.70	65.80	63.80	62.62	61.90	60.35	60.80	61.20	61.15	63.25	63.24	65.96	65.96
1897...	765.30	64.85	63.65	63.10	61.61	60.20	61.60	61.55	61.66	62.80	61.70	64.11	65.30
1898...	764.50	63.84	62.58	62.74	62.22	59.90	60.45	61.00	61.80	60.85	63.05	64.25	64.50
Mean.	764.64	65.13	64.09	62.89	61.67	60.88	60.89	61.37	61.58	62.42	63.32	64.50	65.54

Table III.—*Monthly and annual absolute minima of atmospheric pressure in Manila during the period from 1887 to 1898.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual minima.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887....	756.95	56.22	56.33	53.60	53.97	53.35	53.47	55.50	48.01	55.03	55.06	58.16	48.01
1888....	757.38	58.18	57.70	56.40	55.50	53.90	47.50	53.67	51.04	55.90	56.69	55.18	47.50
1889....	757.97	58.51	56.96	55.90	55.38	55.35	52.00	54.13	53.58	51.03	50.14	50.29	50.14
1890....	755.65	55.36	55.99	54.52	55.17	55.17	53.80	54.55	47.09	52.00	43.50	57.37	43.50
1891....	756.08	57.36	55.80	55.60	55.06	55.35	50.98	53.30	54.13	55.86	48.50	56.72	48.50
1892....	756.47	56.95	56.00	56.16	55.51	52.91	53.82	55.83	50.28	49.80	49.10	56.99	49.10
1893....	756.52	57.58	55.42	54.37	46.12	55.00	53.73	53.32	46.44	49.24	55.75	55.80	46.12
1894....	756.45	58.94	56.18	55.00	53.41	52.63	54.75	55.12	42.34	48.02	54.25	55.53	42.34
1895....	757.27	56.04	56.75	55.11	51.70	53.35	53.67	52.85	52.15	53.98	54.21	57.20	51.70
1896....	758.95	57.85	55.90	55.35	51.10	51.65	50.59	50.23	53.90	50.35	56.20	59.03	50.23
1897....	757.15	56.45	57.20	55.78	54.50	54.51	53.16	52.55	53.20	51.86	54.98	55.85	51.86
1898....	756.90	53.82	53.00	54.91	50.82	53.95	50.90	50.70	53.18	51.85	47.00	54.55	47.00
Mean..	756.98	56.94	56.10	55.23	53.19	53.93	52.36	53.48	50.45	52.08	52.13	56.06	48.00

ABSOLUTE MAXIMUM AND MINIMUM OF ALL THE PERIOD.

The absolute maximum registered in this observatory during these twelve last years was 766.78 mm. and the absolute minimum 742.34 mm., the difference being 24.44 mm.

MONTHLY ABSOLUTE MAXIMA AND MINIMA OF THE WHOLE PERIOD.

The monthly absolute maxima and minima for the whole period which we are considering are the following:

Months.	Maxima.		Minima.	
January	765.70	(1896)	755.65	(1890)
February	766.78	(1891)	753.82	(1898)
March	765.72	(1893)	753.00	(1898)
April	763.52	(1893)	753.60	(1887)
May	762.41	(1891)	746.12	(1893)
June	762.01	(1893)	751.65	(1896)
July	761.78	(1890)	747.50	(1888)
August	762.62	(1888)	750.23	(1896)
September	762.59	(1889)	742.34	(1894)
October	763.43	(1888)	748.02	(1894)
November	764.51	(1890)	743.50	(1890)
December	766.00	(1894)	750.29	(1889)

DISTRIBUTION OF THE ANNUAL MAXIMUMS AND MINIMUMS DURING THE DIFFERENT MONTHS OF THE YEAR.

The twelve annual absolute maximums and minimums are distributed among the different months of the year in this way:

Maxima:	
January	4
February	3
March	2
December	3
Minima:	
May	2
July	1
August	1
September	2
October	1
November	5

So that the greatest number of maximums corresponds to January, and the greatest number of minimums to the month of November, in which, consequently, have occurred the greatest number of the typhoons which in these last years have passed near the capital of the archipelago.

III.—MONTHLY MEANS OF THE DAILY MAXIMA AND MINIMA OF ATMOSPHERIC PRESSURE IN MANILA.—MEAN VALUES OF THE DAILY OSCILLATION.

In Tables IV and V we give the mean monthly values deducted from the absolute maxima and minima of every day in the month, or, in other words, the mean maxima and minima of each month during the period from 1887 to 1898. Table VI has been made up of the difference of these two, which will therefore represent the mean monthly oscillation of atmospheric pressure, oscillation being understood to be the difference between the absolute maxima and minima of each day.

TABLE IV.—*Monthly means of the absolute maxima of atmospheric pressure in Manila during the period from 1887 to 1898.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887...	761.93	62.49	61.64	60.76	59.72	59.52	58.80	59.68	58.41	60.84	61.06	62.06	60.58
1888...	763.14	63.81	62.80	61.39	59.92	58.83	57.18	59.09	59.28	61.47	61.83	62.37	60.93
1889...	763.41	63.33	63.62	61.34	60.56	60.09	59.08	59.50	59.72	59.80	59.71	60.35	60.88
1890...	761.15	62.16	61.20	60.74	59.75	59.57	59.38	59.40	57.78	59.18	61.61	62.37	60.36
1891...	761.76	64.08	62.55	61.63	60.19	59.00	57.87	59.14	59.44	60.68	60.56	63.19	60.84
1892...	762.34	62.06	60.94	60.95	60.10	59.12	58.82	59.91	58.42	59.20	60.20	62.11	60.35
1893...	762.11	62.63	62.48	60.89	59.05	60.18	58.91	58.73	58.19	59.92	61.07	61.68	60.49
1894...	761.68	63.45	61.52	60.74	59.26	59.25	59.14	58.92	58.07	59.87	60.85	62.11	60.41
1895...	762.31	62.94	61.78	60.88	59.15	58.86	59.17	58.19	57.77	60.36	61.72	62.43	60.46
1896...	763.24	63.34	61.87	60.59	59.27	59.32	58.19	58.59	59.54	60.21	61.27	63.76	60.77
1897...	762.97	62.74	62.31	60.96	59.79	58.57	59.64	59.19	59.35	60.10	60.73	61.58	60.66
1898...	762.24	60.68	59.75	60.39	59.21	58.38	58.58	58.42	59.52	58.96	58.73	60.77	59.64
Mean.	762.36	62.81	61.87	60.94	59.66	59.22	58.73	59.06	58.79	60.05	60.78	62.07	60.53

TABLE V.—*Monthly means of the absolute minima of atmospheric pressure in Manila during the period from 1887 to 1898.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887...	759.07	59.51	58.33	57.33	56.72	56.75	56.35	57.00	54.87	58.12	58.34	59.16	57.63
1888...	760.25	60.49	59.44	57.95	56.71	56.16	54.66	56.48	56.28	58.54	59.13	59.37	57.96
1889...	760.32	60.08	60.16	57.83	57.09	57.06	56.33	56.77	56.72	56.75	56.69	57.32	57.76
1890...	758.16	59.07	57.93	57.35	56.71	56.80	56.63	56.62	54.71	56.29	58.46	59.50	57.35
1891...	758.80	60.87	59.07	58.08	56.79	56.20	55.05	56.29	56.68	57.69	57.22	60.16	57.74
1892...	759.27	58.83	57.69	57.74	56.73	56.11	56.20	57.16	55.67	56.01	57.08	59.06	57.30
1893...	759.08	59.45	59.25	57.37	55.73	57.42	56.25	55.99	54.93	56.95	58.31	58.92	57.47
1894...	758.52	60.27	58.08	57.27	56.15	56.28	56.43	56.21	54.29	56.46	57.51	59.12	57.22
1895...	759.03	59.69	58.37	57.57	56.18	55.95	56.46	55.35	55.08	57.12	58.91	59.42	57.43
1896...	760.12	59.95	58.38	57.01	56.50	56.41	55.11	55.51	56.82	57.09	58.92	60.78	57.72
1897...	759.74	59.36	58.88	57.46	56.56	55.85	56.90	56.40	56.36	56.91	57.31	58.82	57.55
1898...	759.47	57.75	56.73	57.06	56.03	55.66	55.95	55.58	56.61	55.92	55.65	57.91	56.69
Mean.	759.32	59.61	58.53	57.50	56.49	56.39	56.03	56.28	55.75	56.99	57.79	59.13	57.49

TABLE VI.—*Mean monthly oscillation of atmospheric pressure in Manila during the period from 1887 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Means.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887	2.86	2.98	3.31	3.43	3.00	2.77	2.45	2.68	3.54	2.72	2.72	2.90	2.95
1888	2.89	3.32	3.36	3.44	3.21	2.67	2.52	2.61	3.00	2.93	2.70	3.00	2.97
1889	3.09	3.25	3.46	3.51	3.47	3.03	2.75	2.73	3.00	3.05	3.02	3.03	3.12
1890	2.99	3.09	3.27	3.39	3.04	2.77	2.75	2.78	3.07	2.89	3.15	2.87	3.01
1891	2.96	3.21	3.48	3.55	3.40	2.80	2.82	2.85	2.76	2.99	3.34	3.03	3.10
1892	3.07	3.23	3.25	3.21	3.37	3.01	2.62	2.75	2.75	3.19	3.12	3.05	3.05
1893	3.03	3.18	3.23	3.52	3.32	2.76	2.66	2.74	3.26	2.97	2.76	2.76	3.02
1894	3.16	3.18	3.44	3.47	3.11	2.97	2.71	2.71	3.78	3.41	3.31	2.99	3.19
1895	3.28	3.25	3.41	3.31	2.97	2.91	2.71	2.84	2.69	3.24	2.81	3.01	3.04
1896	3.12	3.39	3.49	3.58	2.77	2.91	3.08	3.08	2.72	3.12	2.35	2.98	3.05
1897	3.23	3.38	3.43	3.50	3.23	2.72	2.74	2.79	2.99	3.19	3.42	2.76	3.12
1898	2.77	2.93	3.02	3.33	3.18	2.72	2.63	2.84	2.91	3.04	3.08	2.86	2.94
Mean	3.04	3.20	3.35	3.44	3.17	2.84	2.70	2.78	3.04	3.06	2.98	2.94	3.05

ANNUAL MEANS OF THE MAXIMA AND MINIMA—EXTREME MONTHLY MEANS.

The annual means of the maxima and minima do not differ much from each other, excepting only the year 1898, of which the annual mean, both of the maxima and the minima, is much less than those of the other previous years. The extreme monthly means are: The mean of the maxima of the month of February, 1891, 764.08 mm., and the mean of the minima of the month of September, 1894, 754.29 mm.; the months to which, according to what was said in the previous paragraph, the absolute maxima and minima registered in this observatory in all the period of twelve years also belong.

MEAN OSCILLATION OF ATMOSPHERIC PRESSURE IN THE DIFFERENT MONTHS OF THE YEAR.

As regards the last table of the mean monthly oscillation, it is necessary for us to make a most important observation. Without doubt attention will be attracted in it to the fact that the mean value of the oscillation for the months of September, October, and November is equal or greater than that of December and January, and also that the oscillation for June, July, and August is so marked; and this with all the more reason because at first sight it would appear to contradict what we shall say in paragraphs V and VI about the daily variation of atmospheric pressure.

To solve this difficulty it must be borne in mind that in all these tables the days of atmospheric perturbation are included, in which the difference between the absolute maximum and minimum is usually very extraordinary; hence in months such as those cited, in which typhoons are very frequent, it is clear that these extraordinary and abnormal oscillations, often repeated, must have a very marked influence on the value of the mean monthly oscillation. But as, in the study which we shall make in paragraphs V and VI, we have not omitted the days of perturbation why should not the influence of the same on the mean values of the daily and nightly oscillations be noted there in at least as marked a way? The reason is very simple—because said study is not based on the simple comparison or difference of the extreme values of each day, but from all the observations made hour after hour in the course of each month we have deducted the mean values of each one of the twenty-four hours of the day, mean values which have enabled us to indicate the tropical hours of the maxima and minima, or the hours corresponding to the extreme hourly means of day and night. Now, therefore, as the daily maxima and minima of typhoon days may take place at any hour dependent only on the moment when the vortex is nearest, it follows that said extraordinary maxima and minima are distributed for different typhoons in different hours of the day, and therefore their influence in relation to the hourly means is very slight and will be less and less the greater the number of years taken to deduct them may be.

IV.—MAXIMUM AND MINIMUM MONTHLY OSCILLATIONS OF ATMOSPHERIC PRESSURE IN MANILA.

In Tables VII and VIII we include the monthly maximum and minimum oscillations of the period from 1887 to 1898, indicating at the same time the day on which they were observed.

TABLE VII.—*Monthly maximum oscillations of atmospheric pressure in Manila during the period from 1887 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual maximum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887	3.70	4.07	4.30	4.23	3.75	3.70	3.57	3.36	6.23	4.54	4.18	3.43	6.23
1888	3.70	4.32	4.34	4.02	4.26	4.12	7.31	3.73	3.70	3.87	3.50	4.47	7.31
1889	4.58	3.87	4.19	4.34	4.17	4.05	4.32	3.92	4.06	4.86	4.47	5.49	5.49
1890	4.41	4.41	4.40	4.18	3.78	3.51	3.88	3.53	6.04	3.72	9.10	3.72	9.10
1891	3.76	4.03	4.34	4.83	4.72	3.94	4.68	3.92	3.82	3.62	9.02	4.10	9.02
1892	3,98	4.06	4.27	3.81	4.54	4.35	3.43	3.27	4.10	5.14	6.29	3.71	6.29
1893	4.18	3.89	4.20	4.61	8.01	3.56	3.72	4.09	7.77	7.53	3.40	3.73	8.01
1891	4.28	3.90	4.52	4.28	4.14	4.52	4.16	3.86	9.90	10.43	4.20	3.80	10.43
1895	4.17	4.06	4.41	4.10	4.32	3.67	3.41	4.15	4.06	3.44	4.69	4.15	4.69
1896	3.88	4.57	4.40	4.29	3.54	6.73	5.55	6.00	3.55	5.35	3.85	4.00	6.75
1897	3.95	4.20	4.15	4.23	4.01	4.21	4.30	3.69	4.35	4.72	3.40	3.63	4.72
1898	3.80	3.82	4.03	4.00	5.04	3.76	4.90	4.40	3.94	4.45	5.20	3.80	5.20
Mean	4.03	4.10	4.30	4.24	4.52	4.18	4.44	3.99	5.13	5.14	5.11	4.00	6.94

TABLE VIII.—*Monthly minimum oscillations of atmospheric pressure in Manila during the period from 1887 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual minima.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1887	2.36	2.25	2.10	2.46	1.72	1.94	1.58	1.73	2.29	1.85	1.88	2.04	1.58
1888	2.03	2.52	2.65	2.59	2.28	1.88	1.57	1.77	2.40	2.26	2.21	2.34	1.57
1889	2.41	2.52	2.76	2.49	2.90	1.98	1.76	1.96	2.24	1.57	2.02	2.23	1.57
1890	2.48	2.40	2.65	2.51	2.28	1.75	1.54	2.04	2.00	2.10	1.69	2.09	1.54
1891	2.36	2.55	2.66	2.58	2.58	2.09	1.82	1.72	1.96	2.19	2.05	1.90	1.72
1892	2.42	2.30	2.39	2.44	2.32	2.03	1.88	2.05	2.02	2.12	1.86	2.36	1.86
1893	2.44	2.58	2.23	2.36	2.18	1.60	1.96	1.70	1.99	2.17	1.83	1.88	1.60
1894	2.32	2.28	2.48	2.82	2.21	2.10	1.88	1.92	2.09	2.29	2.30	2.43	1.88
1895	2.34	2.00	2.42	2.47	1.93	1.96	1.77	1.93	2.15	2.41	2.02	2.48	1.77
1896	2.13	2.73	2.65	2.33	1.97	1.93	1.77	1.67	2.01	2.08	2.20	2.05	1.67
1897	2.32	2.37	2.60	2.57	2.10	1.75	1.75	1.99	1.91	2.20	2.04	1.93	1.75
1898	1.95	2.28	2.11	2.30	2.12	1.80	1.75	1.80	2.19	2.34	2.30	2.00	1.75
Mean	2.30	2.40	2.48	2.49	2.22	1.90	1.75	1.86	2.10	2.13	2.03	2.14	1.69

MAXIMUM OSCILLATIONS OF THE BAROMETER IN THE DIFFERENT SEASONS OF THE YEAR.

In regard to the result of these tables we must first speak of something similar to what we have already noted in the preceding paragraph, that is to say, that not having discarded the days of atmospheric disturbances, their influence must necessarily be seen in a marked manner on the means of the maximum oscillations corresponding to the months in which typhoons are most frequent. For this reason, according to Table VII, the months of May, September, October, and November have the highest means of maximum oscillation, in which months the greater number of typhoons which have passed near the capital have been observed. If we were to leave out the days when Manila has been under the influence of a typhoon we should see that the maximum barometric oscillation for the months from June to September, both inclusive, would scarcely ever exceed 3 millimeters. On the contrary, the maxima of the months from December to April may be considered as proper to them in normal weather, since they are either wholly exempt from typhoons, or if any are observed they are usually far off and scarcely have any influence on the daily oscillation of atmospheric pressure. Moreover, excepting some special case, such as, for example, the maximum oscillation observed the 4th of December, 1889, it may be asserted that the maximum oscillations of these five months most commonly occur on days of high atmospheric pressure. Hence, the frequency with which in said months, and especially in February, March, and April, barometric oscillations greater than 4 mm. are observed, is worthy of notice.

MINIMUM OSCILLATIONS OF THE BAROMETER PROPER TO EACH MONTH.

The atmospheric perturbations—which, as we have just said, are the chief cause of the maximum oscillations observed in the months of June to November—have scarcely any influence, speaking in general terms, on the minimum oscillations, which are, for this reason, worthy of special mention.

In the first place, examining the minimum oscillations of the four first months of the year from January to April, we find that, with the exception of a single case (January, 1898), all the minimum monthly oscillations are greater than 2 mm. In May three cases in which the minimum monthly oscillation did not reach that extent are recorded. In June, July, and August all the minimum oscillations are less than 2 mm., except the minimums of June, 1891, 1892, and 1894, and August, 1890 and 1892, the only ones which exceeded this value.

From September to December these oscillations of little importance are less frequent, the only cases in which the amount of the minimum monthly oscillation did not reach 2 mm. being 3, 2, 4, and 3 times, respectively, in those months.

EXTREME ANNUAL MAXIMUM AND MINIMUM OSCILLATIONS.

The extreme annual maximum oscillations for all the period from 1887 to 1898 were 10.43 mm. and 4.69, differing by 5.74 mm. The extreme annual minimum oscillations, 1.88 mm. and 1.54 mm., do not differ between themselves more than 0.34 mm.

The difference between the absolute maximum and minimum oscillation of the whole period is 8.89.

The annual maximum and minimum oscillations are distributed among the different months of the years as follows:

Maxima:	
May	1
June	1
July	1
September	1
October	2
November	5
December	1
Minima:	
June	1
July	7
August	2
October	1
November	1

The distribution of the maximum oscillations is, as is seen, very like the distribution of the monthly absolute minima, which we gave in Paragraph II of this chapter. The greatest frequency of annual minimum oscillations corresponds to the month of July, the month in which the monthly mean of the least atmospheric pressure in all the year occurs, as we saw in Paragraph I, and also the least mean oscillation, as may be seen in the following paragraph.

MONTHLY MAXIMUM AND MINIMUM OSCILLATIONS FOR THE WHOLE PERIOD.

The monthly maximum and minimum oscillations for the whole period may be seen in the following table:

Months.	Maximum oscillations.	Minimum oscillations.
	Millimeters.	*Millimeters.*
January	4.58 (1889)	1.95 (1898)
February	4.57 (1896)	2.00 (1895)
March	4.52 (1894)	2.50 (1887)
April	4.83 (1891)	2.30 (1898)
May	8.01 (1893)	1.72 (1887)
June	6.75 (1896)	1.60 (1893)
July	7.31 (1888)	1.54 (1890)
August	6.00 (1896)	1.67 (1896)
September	9.90 (1894)	1.91 (1897)
October	10.43 (1894)	1.57 (1889)
November	9.10 (1890)	1.69 (1890)
December	5.49 (1889)	1.88 (1893)

V.—DAILY VARIATION OF THE ATMOSPHERIC PRESSURE IN MANILA.

IMPORTANCE OF THE LAWS OF THE DAILY OSCILLATION OF THE BAROMETER.

A careful study of the daily course of atmospheric pressure in the Philippines must, without doubt, be of the greatest importance, not only for the better knowledge of the climate of these islands, but mainly to be able to know several days in advance of the existence of a cyclone or typhoon and to seek protection from its fearful effects. The daily oscillation of the barometer is so regular in these latitudes that we have seen it rightly compared by some authors to the movements of a clock; and it may be said with certainty that the least irregularities observed in it are generally the most unmistakable indications of the proximity of some atmospheric disturbance. When we speak further on of the cyclones in the Far East, it will be seen that the rules which worthy Father Faura gave for the right use of his popular barometer are based, at least in a great measure, on the laws which govern the daily oscillation of atmospheric pressure in normal weather or when there is freedom from any noticeable change in the atmosphere.

DOUBLE DAILY OSCILLATION OF ATMOSPHERIC PRESSURE.

Therefore, taking for granted the importance of these laws, let us see, in the first place, what is the daily course of the barometer in the different months of the year. In Table IX we give the hourly monthly means of atmospheric pressure deducted from the period of twelve years, 1887–1898. With these same means we have traced the twelve curves on Plates II and III, which represent graphically the daily oscillation of the barometer in Manila in each one of the twelve months of the year.

In all these curves the double oscillation of the atmospheric pressure in the course of the day is very noticeable, two maxima being always observed, one in the morning and the other at night, and likewise two minima, one at dawn and the other in the afternoon.

TABLE IX.—*Hourly, monthly, annual, and semiannual means of atmospheric pressure in Manila during the period from 1887 to 1898.*

Months.	Forenoon.											
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
January	61.08	60.75	60.49	60.52	60.73	61.07	61.53	62.00	62.27	62.12	61.71	61.09
February	61.46	61.15	60.92	60.92	61.14	61.53	61.99	62.39	62.69	62.64	62.22	61.62
March	60.58	60.24	60.04	60.00	60.21	60.61	61.15	61.53	61.75	61.61	61.28	60.66
April	59.72	59.37	59.11	59.16	59.42	59.76	60.23	60.65	60.80	60.61	60.26	59.72
May	58.53	58.21	58.01	58.02	58.20	58.50	58.91	59.19	59.32	59.20	58.87	58.41
June	58.19	57.88	57.69	57.64	57.75	58.04	58.36	58.55	58.65	58.56	58.30	57.95
July	57.63	57.30	57.10	57.04	57.12	57.39	57.71	57.94	58.07	58.04	57.85	57.54
August	57.97	57.60	57.36	57.32	57.41	57.62	57.98	58.31	58.47	58.41	58.23	57.90
September	57.52	57.17	56.94	56.88	57.04	57.29	57.67	58.09	58.24	58.19	57.95	57.45
October	58.62	58.29	58.09	58.05	58.23	58.67	59.09	59.44	59.66	59.59	59.17	58.61
November	59.42	59.04	58.79	58.79	59.01	59.43	59.87	60.25	60.49	60.36	59.96	59.42
December	60.82	60.44	60.17	60.22	60.43	60.75	61.21	61.72	61.91	61.76	61.37	60.80
Mean	59.30	58.95	58.73	58.71	58.89	59.22	59.64	60.01	60.19	60.09	59.76	59.26
Mean, November to May	60.23	59.89	59.65	59.66	59.88	60.24	60.70	61.10	61.32	61.19	60.81	60.25
Mean, June to October	57.99	57.65	57.44	57.39	57.51	57.80	58.16	58.47	58.62	58.56	58.30	57.89

Month.	Afternoon.												
	1	2	3	4	5	6	7	8	9	10	11	12	Mean.
January	60.32	59.70	59.38	59.51	59.88	60.27	60.71	61.13	61.44	61.52	61.48	61.35	60.92
February	60.82	60.17	59.74	59.74	60.01	60.37	60.78	61.25	61.64	61.84	61.87	61.76	61.28
March	59.86	59.17	58.70	58.63	58.89	59.28	59.74	60.25	60.75	61.02	61.09	60.90	60.33
April	58.88	58.18	57.75	57.62	57.82	58.33	58.86	59.35	59.84	60.21	60.24	59.97	59.41
May	57.77	57.18	56.82	56.70	56.91	57.42	57.92	58.38	58.83	59.13	59.15	58.86	58.27
June	57.44	57.02	56.67	56.59	56.78	57.21	57.65	58.11	58.52	58.81	58.88	58.59	57.91
July	57.07	56.68	56.41	56.29	56.46	56.82	57.24	57.66	58.01	58.30	58.31	58.02	57.42
August	57.31	56.89	56.61	56.53	56.69	57.07	57.51	57.96	58.38	58.67	58.63	58.34	57.72
September	56.81	56.34	56.10	56.15	56.38	56.78	57.22	57.65	58.07	58.29	58.19	57.87	57.35
October	57.98	57.45	57.22	57.34	57.66	57.99	58.46	58.95	59.31	59.42	59.34	59.08	58.57
November	58.72	58.23	58.04	58.15	58.47	58.81	59.29	59.75	60.03	60.11	60.02	59.78	59.34
December	60.04	59.49	59.23	59.36	59.73	60.13	60.59	61.03	61.32	61.38	61.29	61.05	60.68
Mean	58.59	58.04	57.72	57.72	57.97	58.37	58.83	59.29	59.68	59.89	59.87	59.63	59.10
Mean, November to May	59.49	58.87	58.52	58.53	58.82	59.23	59.70	60.16	60.55	60.74	60.73	60.52	60.03
Mean, June to October	57.32	56.88	56.60	56.58	56.79	57.17	57.62	58.07	58.46	58.70	58.67	58.38	57.79

LAWS OF THIS DOUBLE DAILY OSCILLATION IN THE ATMOSPHERIC PRESSURE IN THE DIFFERENT MONTHS OF THE YEAR.

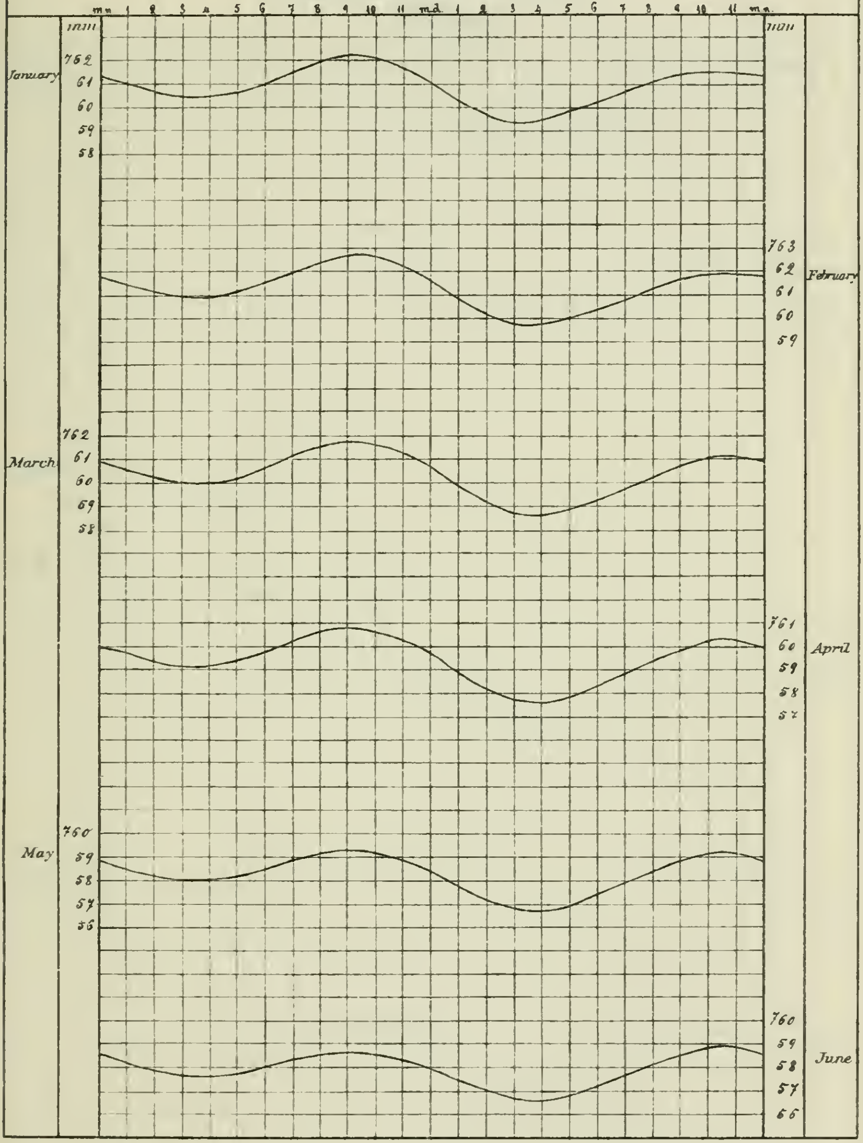
In order that the laws which govern this double daily oscillation of the barometer may be more readily and more clearly recognized, we have made the following table, in which we give separately the four daily semioscillations, with the differences between the maxima and minima, and the hours to which they correspond, all taken from the hourly means of Table IX:

Months.	Diurnal oscillation.				Nocturnal oscillation.			
	Ascent.		Descent.		Ascent.		Descent.	
January	3 a. m. to 9 a. m.	1.78	9 a. m. to 3 p. m.	2.89	3 p. m. to 10 p. m.	2.14	11 p. m. to 3 a. m.	1.03
February	3–4 a. m. to 9 a. m.	1.77	9 a. m to 3–4 p. m.	2.95	3–4 p. m. to 11 p. m.	2.13	11 p. m. to 3–4 a. m.	0.95
March	4 a. m. to 9 a. m.	1.75	9 a. m. to 4 p. m.	3.12	4 p. m. to 11 p. m.	2.46	11 p. m. to 4 a. m.	1.09
April	3 a. m. to 9 a. m.	1.66	9 a. m. to 4 p. m.	3.18	4 p. m. to 11 p. m.	2.62	11 p. m. to 3 a. m.	1.10
May	3 a. m. to 9 a. m.	1.31	9 a. m. to 4 p. m.	2.62	4 p. m. to 11 p. m.	2.45	11 p. m. to 3 a. m.	1.14
June	4 a. m. to 9 a. m.	1.01	9 a. m. to 4 p. m.	2.06	4 p. m. to 11 p. m.	2.29	11 p. m. to 4 a. m.	1.24
July	4 a. m. to 9 a. m.	1.03	9 a. m. to 4 p. m.	1.78	4 p. m. to 11 p. m.	2.02	11 p. m. to 4 a. m.	1.27
August	4 a. m. to 9 a. m.	1.15	9 a. m. to 4 p. m.	1.94	4 p. m. to 10 p. m.	2.14	10 p. m. to 4 a. m.	1.35
September	4 a. m. to 9 a. m.	1.36	9 a. m. to 3 p. m.	2.14	3 p. m. to 10 p. m.	2.19	10 p. m. to 4 a. m.	1.41
October	4 a. m. to 9 a. m.	1.61	9 a. m. to 3 p. m.	2.44	3 p. m. to 10 p. m.	2.20	10 p. m. to 4 a. m.	1.37
November	3–4 a. m. to 9 a. m.	1.70	9 a. m. to 3 p. m.	2.45	3 p. m. to 10 p. m.	2.07	10 p. m. to 3–4 a. m.	1.32
December	3 a. m. to 9 a. m.	1.74	9 a. m. to 3 p. m.	2.68	3 p. m. to 10 p. m.	2.15	10 p. m. to 3 a. m.	1.21
Mean	....	1.49	....	2.52	....	2.24	....	1.21

PLATE II.

DAILY VARIATION OF THE ATMOSPHERIC PRESSURE AT MANILA

1887-1898



DAILY VARIATION OF THE ATMOSPHERIC PRESSURE AT MANILA

1887-1898

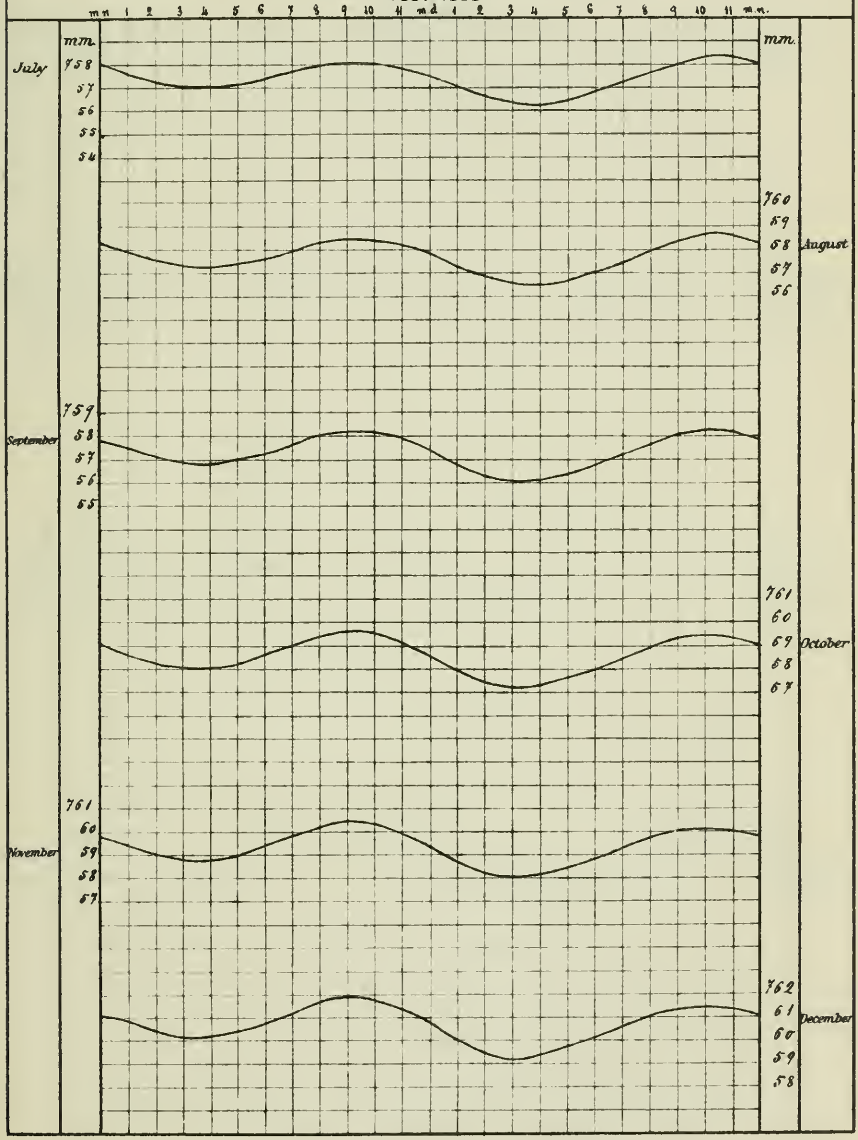
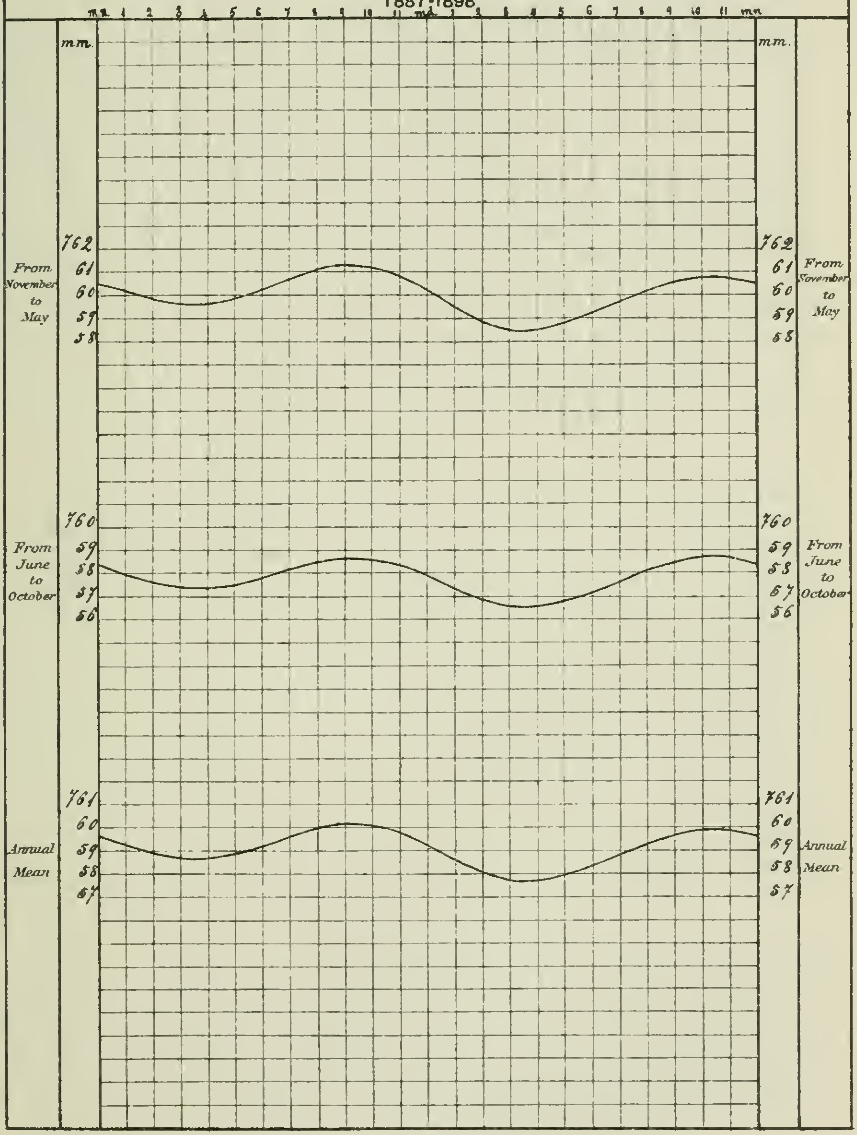


PLATE IV.

DAILY VARIATION OF THE ATMOSPHERIC PRESSURE AT MANILA

1887-1898



From a mere glance at this table the following principal conclusions may be deducted:

(1) The difference between the morning maximum and the afternoon minimum is generally greater than that noticed between the night maximum and the dawn minimum.

(2) The afternoon minimum may be considered in general as the absolute minimum of the whole day. This law is so constant, as may be seen by looking over the leaves of "Extreme values" of our monthly bulletins, that we take the liberty of asserting that with very rare exceptions, the daily minimum is only registered in the morning in days of marked atmospheric disturbance.

(3) The barometer usually rises considerably higher in the nocturnal semioscillation than in the diurnal one.

(4) Hence, considering two entire oscillations, or which consist of one rise and one fall of the barometer, it may be said that the oscillation which takes place from the morning maximum to the night maximum is generally greater than the other, which takes place from the night maximum to the maximum of the following morning.

(5) The mean value of the ascent which the barometer experiences during the night, or in the nocturnal semioscillation, is less than the amount of the previous descent of the diurnal semioscillation in the months of January, February, March, April, May, October, November, and December; but, on the contrary, it is greater in the months of June, July, August, and September.

(6) From the preceding conclusion we deduct that, speaking in general of the whole year, the morning maximum can not be taken as the absolute maximum of the whole day, nor as the maximum daily oscillation the difference between the morning maximum and the afternoon minimum. This can only apply to the months of January, February, March, April, and December, and especially to the first four, in which the afternoon descent is apt to be very much greater than the night ascent. In the months from June to September, the daily maximum will be more frequently observed at night than in the morning, but as the difference between the mean value of the night ascent and that of the previous fall is hardly noticeable, and less than 0.25 mm. in each one of the four months, hence the night maximum can not be taken in general as the daily maximum either. In the months of October and November, although the mean night ascent is less than the afternoon descent, the difference is slight, which supposes that the daily maximum may be registered several times during the night; it being therefore demonstrated in these two months that the morning maximum may be regarded as the absolute maximum of the whole day.

(7) The extent of the mean afternoon descent gradually increases from July to April, and diminishes rapidly from April to July. The difference between the mean extent of these two months is 1.40 mm. The mean amplitude of the night ascent and the dawn descent varies relatively little from one month to another. The mean monthly extent of the morning rise differs somewhat more, which increases progressively from June to February and diminishes from February to June, the difference between the two extremes being 0.76 mm.

(8) The morning maximum is generally observed about 9 o'clock, whereas the night maximum is somewhat later, taking place between 10 and 11 p. m.; nearer 10 in the months of August to January, and nearer 11 in the other six months, from February to July.

(9) The minimums at dawn and in the afternoon are observed, speaking in a general way, between 3 and 4 o'clock. The afternoon minimums are usually registered at 3 in the months of September, October, November, December, and January, and also February (at least in part), or when the sun is in the Southern Hemisphere. In the other months, when the sun is in the Northern Hemisphere, they generally occur at 4. The dawn minimums are observed nearer 4 o'clock in the months of March, June, July, August, September, and October; sometimes nearer 3 and others nearer 4 in February and November, and, finally, they are usually registered at 3, or shortly after, in the months of January, April, May, and December.

LAWS OF THE ANNUAL DAILY OSCILLATION.

Now, formulating a table simiiar to the one we presented of the hourly means of each month for the hourly, annual, and semiannual means, which are at the end of Table IX and in the curves of Plate IV, we shall get this result:

	Diurnal oscillation.				Nocturnal oscillation.			
	Ascent.		Descent.		Ascent.		Descent.	
Annual	4 a. m. to 9 a. m.	1.48	9 a. m. to 3–4 p. m.	2.47	3–4 p. m. to 10 p. m.	2.17	10 p. m. to 4 a. m.	1.18
November to May.	3 a. m. to 9 a. m.	1.67	9 a. m. to 3 p. m	2.80	3 p. m. to 10 p. m.	2.22	10 p. m. to 3 a. m.	1.09
June to October.	4 a. m. to 9 a. m.	1.23	9 a. m. to 4 p. m	2.04	4 p. m. to 10 p. m.	2.12	10 p. m. to 4 a. m.	1.31

According to this table we note in the hourly annual variation:

(1) That the least semioscillation corresponds to the dawn descent, and the greatest to the afternoon descent;

(2) That the night ascent is noticeably greater than that of the morning; and

(3) That the morning maximums and the afternoon minimums correspond, respectively, to 9 and to 3 and 4 o'clock; whereas the night maximum and the dawn minimum correspond to 10 and 4 o'clock.

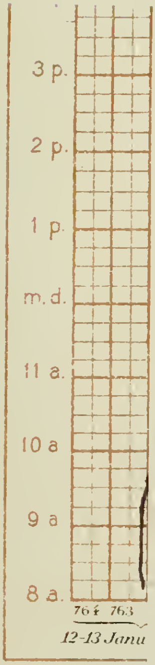
THE DAILY OSCILLATION OF THE BAROMETER IN THE PERIODS FROM JUNE TO OCTOBER AND FROM NOVEMBER TO MAY.

Between the two semiannual variations the following most remarkable differences are observed:

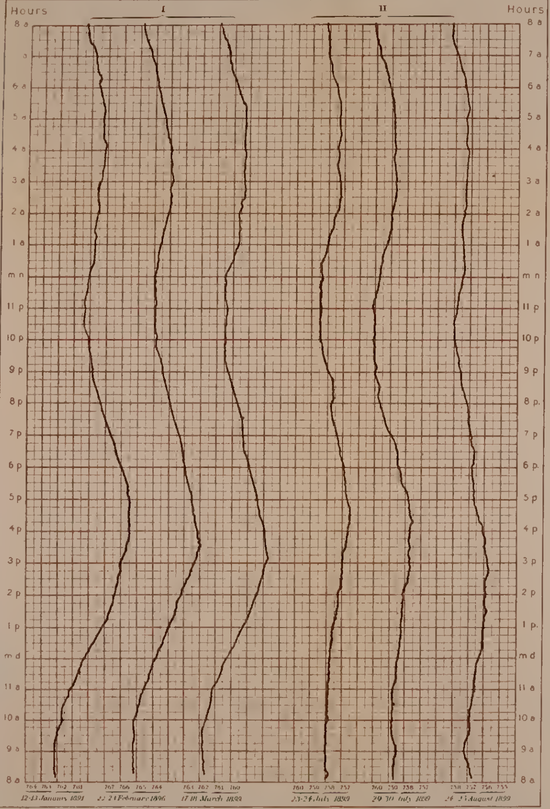
(1) The amplitude of the semioscillations of the morning, afternoon, and night is greater in the mean of the period from November to May than in the other from June to October, the dawn semioscillation being, on the contrary, less.

(2) The ascent of the nocturnal semioscillation is less than the descent of the previous diurnal one in the mean of the period from November to May, but is greater in the mean of the other period.

(3) The afternoon minimums, as well as the dawn minimums, occur at 3 o'clock in the first period and at 4 in the second. The morning maximum is in both periods at 9 o'clock, and the night maximum at 10.


3 p.
2 p.
1 p.
m. d.
11 a.
10 a
9 a
8 a.
76 4
763
12-13 Janu

FACSIMILE OF SOME CURVES REGISTERED BY THE SPRUNG-FUESS BAROGRAPH OF THE MANILA OBSERVATORY IN NORMAL ATMOSPHERIC PRESSURE DAYS



I *Months of greatest barometric oscilation*

II *Months of least barometric oscilation*

CURVES TRACED IN NORMAL WEATHER BY THE SPRUNG-FUESS BAROGRAPH OF THE MANILA OBSERVATORY.

To illustrate this most important subject, we have selected among the curves traced in normal weather by the Sprung-Fuess barograph, three which may be regarded as typical for the months in which the greatest barometric oscillation occurs, and three others proper to the months of the least oscillation.

We have intentionally given preference to curves in which the oscillation has been somewhat more pronounced than ordinary, in both directions, in order that the difference may thus be more marked.

VI.—THE HOURLY MEANS OF ATMOSPHERIC PRESSURE COMPARED WITH EACH OTHER AND WITH THE MONTHLY MEANS.

In order to fully confirm the laws which, as we have seen in the preceding paragraph, govern the daily oscillation of the barometer in Manila, and in order to deduct some others besides, of no less importance, we have made Table X, in which we shall not do more than give the differences between each one of the hourly means of Table IX and the respective monthly means, adding below, as auxiliary data, the mean value of the ascent or descent between each one of the twenty-four hours and that immediately preceding.

TABLE X.—*Difference between the hourly means compared with each other, and between the same hourly means and the monthly means of atmospheric pressure in Manila.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1 a. m	**0.16**	**0.18**	**0.25**	**0.31**	**0.26**	**0.28**	**0.21**	**0.25**	**0.17**	**0.05**	**0.08**	**0.14**	**0.20**
0–1 a. m	− 0.27	− 0.30	− 0.32	− 0.25	− 0.33	− 0.40	− 0.39	− 0.37	− 0.35	− 0.46	− 0.36	− 0.23	− 0.33
2 a. m	**− 0.17**	**− 0.13**	**− 0.09**	**− 0.04**	**− 0.06**	**− 0.03**	**− 0.12**	**− 0.12**	**− 0.18**	**− 0.28**	**− 0.30**	**− 0.24**	**− 0.15**
1–2 a. m	− 0.33	− 0.31	− 0.34	− 0.35	− 0.32	− 0.31	− 0.33	− 0.37	− 0.35	− 0.33	− 0.38	− 0.38	− 0.35
3 a. m	**− 0.43**	**− 0.36**	**− 0.29**	**− 0.27**	**− 0.26**	**− 0.22**	**− 0.32**	**− 0.36**	**− 0.41**	**− 0.48**	**− 0.55**	**− 0.51**	**− 0.37**
2–3 a. m	− 0.26	− 0.23	− 0.20	− 0.23	− 0.20	− 0.19	− 0.20	− 0.24	− 0.23	− 0.20	− 0.25	− 0.27	− 0.22
4 a. m	**− 0.40**	**− 0.36**	**− 0.33**	**− 0.25**	**− 0.25**	**− 0.27**	**− 0.38**	**− 0.40**	**− 0.47**	**− 0.52**	**− 0.55**	**− 0.46**	**− 0.39**
3–4 a. m	0.03	0.00	− 0.04	0.02	0.01	− 0.05	− 0.06	− 0.04	− 0.06	− 0.04	0.00	0.05	− 0.02
5 a. m	**− 0.19**	**− 0.14**	**− 0.12**	**0.01**	**− 0.07**	**− 0.16**	**− 0.30**	**− 0.31**	**− 0.31**	**− 0.34**	**− 0.33**	**− 0.25**	**− 0.21**
4–5 a. m	0.21	0.22	0.21	0.26	0.18	0.11	0.08	0.09	0.16	0.18	0.22	0.21	0.18
6 a. m	**0.15**	**0.25**	**0.31**	**0.35**	**0.23**	**0.13**	**− 0.03**	**− 0.10**	**− 0.06**	**0.10**	**0.09**	**− 0.07**	**0.12**
5–6 a. m	0.34	0.39	0.43	0.34	0.30	0.29	0.27	0.21	0.25	0.44	0.42	0.18	0.33
7 a. m	**0.61**	**0.71**	**0.82**	**0.82**	**0.64**	**0.45**	**0.29**	**0.26**	**0.32**	**0.52**	**0.53**	**0.53**	**0.54**
6–7 a. m	0.46	0.46	0.51	0.47	0.41	0.32	0.32	0.36	0.38	0.42	0.44	0.60	0.42
8 a. m	**1.08**	**1.11**	**1.20**	**1.24**	**0.92**	**0.64**	**0.52**	**0.59**	**0.74**	**0.87**	**0.91**	**1.04**	**0.91**
7–8 a. m	0.47	0.40	0.38	0.42	0.28	0.19	0.23	0.33	0.42	0.35	0.38	0.51	1.37
9 a. m	**1.35**	**1.41**	**1.42**	**1.39**	**1.05**	**0.74**	**0.65**	**0.75**	**0.89**	**1.09**	**1.15**	**1.23**	**1.09**
8–9 a. m	0.27	0.30	0.22	0.15	0.13	0.10	0.13	0.16	0.15	0.22	0.24	0.19	0.18
10 a. m	**1.20**	**1.36**	**1.28**	**1.20**	**0.93**	**0.65**	**0.62**	**0.69**	**0.84**	**1.02**	**1.02**	**1.08**	**0.99**
9–10 a. m	− 0.15	− 0.05	− 0.14	− 0.19	− 0.12	− 0.09	− 0.03	− 0.06	− 0.05	− 0.07	− 0.13	− 0.15	− 0.10
11 a. m	**0.79**	**0.94**	**0.95**	**0.85**	**0.60**	**0.39**	**0.43**	**0.51**	**0.60**	**0.60**	**0.62**	**0.69**	**0.66**
10–11 a. m	− 0.41	− 0.42	− 0.33	− 0.35	− 0.33	− 0.26	− 0.19	− 0.18	− 0.24	− 0.42	− 0.40	− 0.39	− 0.33
12 noon	**0.17**	**0.34**	**0.33**	**0.31**	**0.14**	**0.04**	**0.12**	**0.18**	**0.10**	**0.04**	**0.08**	**0.12**	**0.16**
11–12 noon	− 0.62	− 0.60	− 0.62	− 0.54	− 0.46	− 0.35	− 0.31	− 0.33	− 0.50	− 0.56	− 0.54	− 0.57	− 0.50
1 p. m	**− 0.60**	**− 0.46**	**− 0.47**	**− 0.53**	**− 0.50**	**− 0.47**	**− 0.35**	**− 0.41**	**− 0.54**	**− 0.59**	**− 0.62**	**− 0.64**	**− 0.51**
12–1 p. m	− 0.77	− 0.80	− 0.80	− 0.84	− 0.62	− 0.51	− 0.47	− 0.59	− 0.64	− 0.63	− 0.70	− 0.76	− 0.67
2 p. m	**− 1.22**	**− 1.11**	**− 1.16**	**− 1.23**	**− 1.09**	**− 0.89**	**− 0.74**	**− 0.83**	**− 1.01**	**− 1.12**	**− 1.11**	**− 1.19**	**− 1.06**
1–2 p. m	− 0.62	− 0.65	− 0.69	− 0.70	− 0.59	− 0.42	− 0.39	− 0.42	− 0.47	− 0.53	− 0.49	− 0.55	− 0.55
3 p. m	**− 1.54**	**− 1.54**	**− 1.63**	**− 1.66**	**− 1.45**	**− 1.24**	**− 1.01**	**− 1.11**	**− 1.25**	**− 1.35**	**− 1.30**	**− 1.45**	**− 1.38**
2–3 p. m	− 0.32	− 0.43	− 0.47	− 0.43	− 0.36	− 0.35	− 0.27	− 0.28	− 0.24	− 0.23	− 0.19	− 0.26	− 0.32

4 p. m	**— 1.41**	**— 1.54**	**— 1.70**	**— 1.79**	**— 1.57**	**— 1.32**	**— 1.13**	**— 1.19**	**— 1.20**	**— 1.23**	**— 1.19**	**— 1.32**	**— 1.38**
3–4 p. m	0.13	0.00	— 0.07	— 0.13	— 0.12	— 0.08	— 0.12	— 0.08	0.05	0.12	0.11	0.13	0.00
5 p. m	**— 1.04**	**— 1.27**	**— 1.44**	**— 1.59**	**— 1.36**	**— 1.13**	**— 0.96**	**— 1.03**	**— 0.97**	**— 0.91**	**— 0.87**	**— 0.95**	**— 1.13**
4–5 p. m	0.37	0.27	0.26	0.20	0.21	0.19	0.17	0.16	0.23	0.32	0.32	0.37	0.25
6 p. m	**— 0.65**	**— 0.91**	**— 1.05**	**— 1.08**	**— 0.85**	**— 0.70**	**— 0.60**	**— 0.65**	**— 0.57**	**— 0.58**	**— 0.53**	**— 0.55**	**— 0.73**
5–6 p. m	0.39	0.36	0.39	0.51	0.51	0.43	0.36	0.38	0.40	0.33	0.34	0.40	0.40
7 p. m	**— 0.21**	**— 0.50**	**— 0.59**	**— 0.55**	**— 0.35**	**— 0.26**	**— 0.18**	**— 0.21**	**— 0.13**	**— 0.11**	**— 0.05**	**— 0.09**	**— 0.27**
6–7 p. m	0.44	0.41	0.46	0.53	0.50	0.44	0.42	0.44	0.44	0.47	0.48	0.46	0.46
8 p. m	**0.21**	**— 0.03**	**— 0.08**	**— 0.06**	**0.11**	**0.20**	**0.24**	**0.24**	**0.30**	**0.38**	**0.41**	**0.35**	**0.19**
7–8 p. m	0.42	0.47	0.51	0.49	0.46	0.46	0.42	0.45	0.43	0.49	0.46	0.44	0.46
9 p. m	**0.52**	**0.36**	**0.42**	**0.43**	**0.56**	**0.61**	**0.59**	**0.66**	**0.72**	**0.74**	**0.69**	**0.64**	**0.58**
8–9 p. m	0.31	0.39	0.50	0.49	0.45	0.41	0.35	0.42	0.42	0.36	0.28	0.29	0.39
10 p. m	**0.60**	**0.56**	**0.69**	**0.80**	**0.86**	**0.90**	**0.88**	**0.95**	**0.94**	**0.85**	**0.77**	**0.70**	**0.79**
9–10 p. m	0.08	0.20	0.27	0.37	0.30	0.29	0.29	0.29	0.22	0.11	0.08	0.06	0.21
11 p. m	**0.56**	**0.59**	**0.76**	**0.83**	**0.88**	**0.97**	**0.89**	**0.91**	**0.84**	**0.77**	**0.68**	**0.61**	**0.77**
10–11 p. m	— 0.04	0.03	0.07	0.03	0.02	0.07	0.01	— 0.04	— 0.10	— 0.08	— 0.09	— 0.09	— 0.02
12 Midnight	**0.43**	**0.48**	**0.57**	**0.56**	**0.59**	**0.68**	**0.60**	**0.62**	**0.52**	**0.51**	**0.44**	**0.37**	**0.53**
11–12 midnight	— 0.13	— 0.11	— 0.19	— 0.27	— 0.29	— 0.29	— 0.29	— 0.29	— 0.32	— 0.26	— 0.24	— 0.24	— 0.24
Mean	**0.65**	**0.69**	**0.75**	**0.76**	**0.65**	**0.56**	**0.51**	**0.56**	**0.59**	**0.63**	**0.62**	**0.63**	**0.63**
Mean	0.33	0.33	0.35	0.36	0.31	0.28	0.25	0.27	0.30	0.32	0.31	0.32	0.30

CONCLUSIONS DEDUCTED FROM THIS TABLE—HOURS IN WHICH THE ASCENT OR DESCENT OF THE BAROMETER IS USUALLY GREATER OR LESS.

A careful examination of the first part of this table, which contains the differences between the hourly means and the monthly means, serves principally to confirm in a marvelous manner all that we have said regarding the laws of the double daily oscillation of the barometer; but, in the second place, or from the differences between each one of the hourly means and that immediately preceding, the following conclusions may also be deducted:

(1) In general, the fall of the barometer is more marked from 0 to 2 a. m. and from 11 a. m. to 2 p. m. than in the other hours of descent.

(2) Among the hours of ascent this is much more pronounced from 5 to 8 a. m. and from 5 to 9 p. m.

(3) In all the months the difference between 3 and 4 a. m. and 3 and 4 p. m. are very insignificant, which confirms the fact that between these two hours the minimums of the dawn and of the afternoon must take place.

(4) The least morning differences are observed, with the exception of the month of April. between 9 and 10 a. m., it being observed, besides, that even in the other months the difference between these two hours is very small, if it is compared with that between 10 and 11 a. m. From this may be deducted, in confirmation of what was said in the preceding paragraph, that the morning maximum is usually registered in the neighborhood of 9, at times a little before this hour, but more commonly a little after—that is to say, between 9 and 9.30 a. m.

(5) The least night difference is from 10 to 11 p. m., except in November and December, in which the difference is least from 9 to 10 p. m. This would tend to prove that in these last two months the hour of the nightly maximum advances a little, which is generally registered between 10 and 11 p. m.

(6) In general, the differences are less in the hours nearest the maximums and minimums, and they increase as they depart from them and again gradually diminish as the following maximum or minimum approaches; and, indeed, examining day by day the curves traced by the Sprung-Fuess barograph since it was installed in this observatory, in 1886, it is noted that in the neighborhood of the maximums and minimums the atmospheric pressure remains for a time little less than stationary, without rising or falling, the beginning and the end, both of the barometric ascent and descent, being, besides, generally very low

VII.—ANNUAL VARIATION OF ATMOSPHERIC PRESSURE IN DIFFERENT POINTS OF THE ARCHIPELAGO.

OBJECT OF THIS PARAGRAPH AND METHOD FOLLOWED TO FIND THE BAROMETRIC MEANS OF VARIOUS PHILIPPINE STATIONS.

Neither the time nor the data at our disposal permit us to make a complete and careful study of the annual variation, and much less of the daily variation, of the atmospheric pressure in the different islands which compose the Philippine Archipelago. And, on the other hand, what has been said of Manila is applicable, with slight variations, to all of them; hence we content ourselves for the present by choosing a few of the principal stations and giving the monthly means of several years of observation, leaving further investigations on this subject for other works which could be accomplished with better success when there are more data and a greater number of meteorological stations, especially in Visayas and Mindanao.

Considering that even in the official stations in Luzon only five or six daily observations were made, which were frequently interrupted on account of urgent telegraphic services, no other means has occurred to us to find in a somewhat approximate manner the barometric means of said stations than to take as such the means of the observations of 10 a. m. and 4 p. m., hours which are not far removed from the maximum and minimum of the diurnal oscillation. And although it is true that the absolute daily maximum during certain months of the year is observed rather at night than in the morning, as we said in paragraph V, still, as we are only dealing with an approximate value, and mainly desiring to see the relative annual variation of atmospheric pressure in different regions of the Philippines, it is readily seen that said method is not to be in any way despised, especially as we can not rely upon other data of greater accuracy.

ATMOSPHERIC PRESSURE IN APARRI AND ALBAY.

Having briefly indicated the method we have followed in finding the monthly means, let us take up in the first place the stations of Aparri and Albay, located at the two extremes north and south of Luzon, collecting in the two Tables XI and XII the means of the period of ten years, from 1886 to 1895.

Table XI.—*Monthly and annual barometric means at the station of Aparri during the period from 1886 to 1895.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1886	763.1	64.1	62.3	59.8	59.0	57.6	......	57.5	57.2	60.0	62.0	63.6	....
1887	762.1	62.6	61.8	60.0	58.9	57.8	56.3	58.2	56.5	59.7	61.3	62.6	59.8
1888	764.1	63.5	62.5	60.7	58.9	56.9	56.1	57.1	58.6	61.9	62.4	63.2	60.5
1889	764.1	61.1	63.6	60.7	59.8	58.6	57.6	57.7	58.9	59.1	60.4	62.4	60.5
1890	762.5	62.8	61.6	60.5	58.8	58.3	57.5	58.0	55.6	57.9	61.3	61.5	59.7
1891	762.1	63.2	60.9	59.7	57.7	55.7	54.7	56.1	55.8	59.2	60.0	63.3	59.0
1892	762.2	60.5	59.4	58.5	56.8	......	55.9	57.3	54.6	57.1	59.5	63.0	....
1893	761.2	61.5	61.0	59.4	56.8	58.9	56.3	56.5	55.0	59.2	63.0	63.0	59.3
1894	761.9	63.9	61.4	59.7	57.9	57.0	57.1	56.8	56.2	59.3	60.8	63.0	59.6
1895	762.8	63.1	61.9	60.3	58.1	57.1	57.1	56.0	55.7	59.8	62.4	63.6	59.8
Mean	762.6	62.9	61.6	59.9	58.3	57.5	56.5	57.1	56.4	59.3	61.3	62.9	59.8

Table XII.—*Monthly and annual barometric means at the station of Albay during the period from 1886 to 1895.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1886	761.7	62.2	61.7	59.5	58.9	58.9	......	57.8	57.6	58.8	59.5	59.9	....
1887	760.5	60.8	60.2	60.0	58.4	58.3	57.8	58.3	57.1	59.3	59.5	60.3	59.2
1888	761.2	62.4	61.4	60.6	58.9	57.8	56.3	58.0	58.0	60.0	60.4	61.1	59.7
1889	757.2	62.2	62.6	60.5	59.6	58.8	57.9	58.3	58.0	57.3	......	58.6	....
1890	....	60.9	60.1	59.6	58.7	58.0	56.7	56.9	55.0	56.6	59.7	59.9	....
1891	759.5	62.3	60.8	59.9	58.7	57.1	56.2	57.1	57.6	58.6	58.3	60.7	58.9
1892	759.8	60.2	59.1	59.3	58.1	57.3	57.0	58.0	56.5	56.8	57.7	59.7	58.3
1893	760.0	60.8	60.7	59.1	57.1	58.5	57.2	57.0	56.6	58.0	59.1	59.7	58.7
1894	759.8	61.5	59.6	59.4	57.6	57.8	57.4	57.2	56.6	58.0	58.9	60.2	58.7
1895	760.3	61.4	60.2	59.5	58.0	57.4	57.9	56.6	56.3	58.5	60.0	60.7	58.9
Mean	760.0	61.5	60.6	59.7	58.4	58.0	57.2	57.5	56.9	58.2	59.2	60.1	58.9

MONTHLY MEANS OF APARRI AND ALBAY COMPARED WITH THOSE OF MANILA.

Comparing the means of both stations with each other and with those of Manila, it is seen that the maximum and minimum pressures are observed in the same months in the three points cited; but both, and especially the first, are much more pronounced in Aparri than in Manila and Albay, and for the same reason the annual variation of the atmospheric pressure is greater in that station than in the two latter.

ANNUAL MEANS.

The annual mean of Aparri is 759.8 mm., and that of Albay 758.9 mm., differing, respectively, from that of Manila by 0.5 and 0.4 mm.

In Tables XIII and XIV we give the monthly barometric maxima observed at 10 a. m. in the same two stations of Aparri and Albay.

TABLE XIII.—*Monthly barometric maxima observed at 10 a. m. in the station of Aparri during the period from 1886 to 1895.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1886	768.8	68.4	66.1	63.7	63.1	61.8	......	60.4	61.7	63.9	65.8	68.3	....
1887	767.1	68.8	65.0	64.7	61.6	61.5	61.3	60.9	62.2	64.3	65.8	64.7	68.8
1888	768.5	68.0	67.4	63.8	62.5	60.4	60.7	62.1	62.1	66.6	66.9	68.0	68.5
1889	768.2	68.2	68.2	63.3	63.1	61.6	61.2	60.7	62.1	63.5	66.9	67.4	68.2
1890	768.2	67.7	66.8	64.9	62.0	61.7	61.9	61.0	58.6	63.9	65.3	64.4	68.2
1891	766.2	69.0	65.6	63.9	62.3	58.8	59.0	60.3	60.6	63.9	66.2	67.7	69.0
1892	767.7	65.9	63.7	63.4	......	......	59.5	59.8	60.2	61.8	61.6	66.4	....
1893	767.3	65.5	66.8	64.5	61.5	61.3	59.8	59.7	61.1	65.3	65.9	67.2	67.3
1894	767.1	67.8	68.3	63.2	61.5	61.0	59.7	60.3	61.3	63.1	65.7	69.1	69.1
1895	766.1	67.5	66.9	65.0	62.6	59.6	60.9	60.6	59.6	62.2	67.0	67.6	67.6
Mean	767.5	67.7	66.5	64.0	62.2	60.9	60.4	60.6	61.0	63.9	66.0	67.1	68.3

TABLE XIV.—*Monthly barometric maxima observed at 10 a. m. in the station of Albay during the period from 1886 to 1895.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Means.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1886	765.9	66.0	65.6	63.0	61.3	61.5	......	60.5	59.8	61.8	62.5	62.7	....
1887	764.0	64.8	63.2	64.6	61.6	61.3	60.7	61.2	61.0	62.2	62.3	62.5	64.8
1888	764.3	66.4	63.8	62.8	62.2	60.5	60.0	61.6	60.8	63.3	63.9	64.7	66.4
1889	764.3	64.6	66.4	62.9	62.5	61.4	60.8	62.3	62.4	60.4	......	62.9	....
1890	....	63.9	62.5	63.1	62.2	61.5	61.0	59.4	58.7	61.1	63.0	62.3	....
1891	763.1	66.2	63.9	62.8	61.9	60.1	59.5	60.2	61.7	62.5	62.1	64.0	66.2
1892	764.0	62.9	62.1	62.5	60.8	60.4	59.8	60.1	60.9	61.1	61.0	63.1	64.0
1893	764.5	64.9	64.6	63.1	60.2	61.7	60.0	61.0	60.8	61.5	62.3	62.9	64.9
1894	762.9	64.6	64.1	62.7	61.1	60.4	59.7	59.4	60.9	60.7	62.3	64.9	64.9
1895	762.9	64.5	63.6	62.5	61.0	60.2	60.6	60.1	60.3	60.7	63.6	64.0	64.5
Mean	764.0	64.9	64.0	63.0	61.5	60.9	60.2	60.6	60.7	61.5	62.6	63.4	65.2

MAXIMUM BAROMETRIC HEIGHTS AT APARRI AND ALBAY.

We have already seen, in paragraph II of this chapter, that the absolute maximum observed in Manila in all the period from 1887 to 1898 was 766.78 mm., whereas in Aparri it reached 769.1 mm. in December, 1894, and 769 in February, 1891, its attaining the height of 767 mm. and 768 mm. during the months of December, January, February, and March being even less rare. That was not the case in Albay, where the maximum for the period from 1886 to 1895 did not exceed 766.4 mm., observed in February, 1888, and March, 1889.

ATMOSPHERIC PRESSURE AT OTHER POINTS IN THE ARCHIPELAGO.

In Table XV we have grouped together, besides the monthly means of Manila, Aparri, and Albay, those of eight other stations in Luzon, which are the following: Dáet, on the eastern coast; San Isidro, Bayombong, and Tuguegarao, of the center of the island, and Bolinas, Vigan, Laoag, and Punta Santiago, on the western coast. We add at the end of the same table the means derived from a few years of observation for Iloilo, Calbáyog, and Zamboanga.[1]

TABLE XV.—*Monthly barometric means of various stations of Luzon, Visayas, and Mindanao.*

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years of observation.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	
Aparri	762.6	62.9	61.6	59.9	58.3	57.5	56.5	57.1	56.4	59.3	61.3	62.9	10
Laoag	761.19	61.47	60.52	59.65	58.08	57.59	57.16	57.19	56.49	58.09	59.75	61.25	6
Tuguegarao	762.29	61.92	60.65	59.15	57.33	57.03	56.49	56.47	56.14	58.40	60.57	62.53	6
Vigan	760.47	60.92	59.72	58.81	57.33	56.98	56.53	56.56	55.95	57.66	59.06	60.57	6
Bayombong	761.62	61.58	60.36	59.09	57.43	57.15	56.48	56.45	56.01	58.28	60.08	61.88	6
Cabo Bolinao	760.91	61.14	59.95	58.93	57.63	57.24	56.95	56.91	56.42	58.25	59.40	61	6
San Isidro	761.08	61.32	60.18	59.02	57.68	57.71	57.53	57.31	57.16	58.38	59.69	61.22	6
Manila	761.27	61.52	60.60	59.57	58.47	58.08	57.50	57.75	57.62	58.88	59.55	60.92	16
Dáet	762.29	61.75	60.79	59.75	57.98	57.67	57.07	56.95	56.67	58.31	59.47	61.21	6
Punta Santiago	760.68	61.08	60.07	59.13	58.39	57.68	57.58	57.49	57.28	58.36	59.23	60.37	6
Albay	760.00	61.5	60.6	59.7	58.4	58.00	57.2	57.5	56.9	58.2	59.2	60.1	10
Calbáyog (Sámar)	759.70	60.64	59.39	58.91	58.01	57.72	57.60	57.08	56.98	57.95	58.75	59.21	3
Iloilo	758.9	60.2	58.8	58.2	57.8	57.9	57.7	57.7	57.9	58.3	58.7	59.2	4
Zamboanga	759.1	59.9	58.7	59.2	57.8	58.9	59.3	59.6	59.2	59.8	59.1	58.3	2

The annual means may be seen in the following schedule:

Stations.	Annual mean.	Complete years of observation.
	Millimeters.	
Aparri	59.78	8
Laoag	59.04	6
Tuguegarao	59.13	5
Vigan	58.28	5
Bayombong	58.87	6
Cabo Bolinas	58.69	3
San Isidro	59.02	6
Manila	59.31	16
Dáet	59.08	6
Punta Santiago	58.91	5
Albay	58.91	7
Calbáyog (Sámar)	58.48	2
Iloilo	58.70	2

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[1] We have chosen just these three stations because there are in them good mercurial barometers. There were also some in the farm houses of La Carlota and Cebú; but they must have had an instrumental error which is unknown to us. The Iloilo observations are from the agronomic station established there. We owe those from Calbáyog to the generosity of the teacher, Don Bío Santos, and finally we have to thank for those of Zamboanga the care of Father Baltasar Ferrer, S. J., to whom this observatory is indebted for valuable observations made by him during his two years' residence in the capital of Mindanao.

If these annual means are compared with those which could be obtained from the monthly means of Table XV differences will be noted in some stations due to the fact that in calculating the annual mean we have omitted some incomplete years of observation which we took into account in deducting the monthly means.

REMARKABLE BAROMETRIC INCLINATION TOWARD THE NORTH-NORTHEAST IN LUZÓN DURING THE MONTHS OF HIGH ATMOSPHERIC PRESSURE.

Comparing the normal monthly means of the stations in Luzón included in Table XV with each other, a very remarkable fact worthy of attracting our attention is noted, which we shall only briefly indicate. We refer to the barometric inclination which exists in the island of Luzón during the months of high atmospheric pressures, from Aparri to Laoag, Vigan, and Cabo Bolinas. The center of maximum pressure in these months of December, January, February, and March being in the interior of the continent of Asia and to the north-northwest of Luzón, it would appear natural that the stations of Aparri and Laoag, being almost on the same parallel, one at the north and the other at the northwest of the island, the same isobar would reach both, greater than those corresponding to the other stations located in lower parallels. However, it is not so, but on the contrary, we may say that whereas Laoag, Vigan, and Cabo Bolinas are almost in the same isobar as Manila, the atmospheric pressure rises in a remarkable manner from Manila to Bayombong, from Bayombong to Tuguegarao, and from Tuguegarao to Aparri, the isobar of this latter place being on an average 2 mm. greater than that of Vigan and Laoag. And even on days when the pressure reaches its maximum it exceeds it by 3 and even 4 mm. So that it appears as if a center of high pressure exists toward the north-northeast of Luzón, extending its isobars in the form of an ellipse, whose longer axis is inclined from north-northeast to south-southwest.

THE ANNUAL VARIATION OF THE ATMOSPHERIC PRESSURE IN MANILA COMPARED WITH THAT OF VISAYAS AND MINDANAO.

Moreover, the annual variation of the atmospheric pressure in Manila, and in general in southern Luzón, differs little from that observed in Visayas and Mindanao. On the whole, according to the data from Zamboanga, it appears as though it could be said that the barometer there does not rise as high as in Manila in the months of high pressure, and, on the contrary, it remains a little higher in the months in which atmospheric disturbances are most frequent, or from June to September.

CHAPTER III.

TEMPERATURE OF THE AIR.

I.—ANNUAL VARIATION OF THE TEMPERATURE OF THE AIR IN MANILA.

THE MEAN TEMPERATURE OF THE AIR IN MANILA IN THE DIFFERENT MONTHS OF THE YEAR.

In Table XVI we give the annual course of the temperature of the air in Manila, deducted from 24 daily observations and from sixteen years of observation (1883–1898). According to this table, the mildest month is January, the months of December and February following in the second place; the temperature rises considerably in the month of March, reaching its maximum in May; it diminishes very gradually from May to July, and from August to September; in August it keeps the same degree of heat as in July, and in October the same also as in September, and it again diminishes from October to January, but in this second part of the year, or, in the months in which the temperature decreases, the sudden jumps which occur in the first part are not noted if the mean normal temperature of February is compared with the normal temperature of March and the latter with that of April.

Table XVI.—*Mean monthly and annual temperatures for the period from 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*
1883	25.2	25.6	27.7	28.2	28.7	27.1	26.7	27.4	26.5	26.5	26.0	24.1	26.6
1884	23.6	24.7	26.4	27.8	28.2	27.0	26.3	26.5	26.6	26.6	25.9	24.3	26.2
1885	24.6	24.4	26.1	27.3	28.5	28.3	27.3	27.1	27.6	27.3	26.4	25.2	26.7
1886	25.2	24.7	26.4	28.3	28.5	27.5	27.0	27.5	27.1	26.6	26.0	24.9	26.6
1887	25.2	25.3	26.7	27.7	27.7	27.6	27.1	27.3	26.3	26.4	26.1	25.4	26.6
1888	24.9	25.2	27.5	28.7	29.2	27.8	26.1	27.2	27.6	26.3	26.5	26.0	26.9
1889	25.8	26.4	27.5	29.4	30.3	28.7	27.5	27.3	27.5	27.1	26.5	24.9	27.4
1890	25.6	25.9	27.3	27.9	27.9	27.3	27.3	27.4	26.5	26.1	25.4	25.2	26.6
1891	24.6	25.0	26.7	28.6	29.8	27.6	26.8	26.6	26.8	27.4	26.3	25.5	26.8
1892	25.3	26.0	27.1	28.0	28.8	28.1	27.3	27.0	26.7	27.1	25.8	25.0	26.9
1893	24.1	25.4	26.5	28.3	27.8	27.7	27.3	27.7	26.6	26.5	25.7	25.4	26.6
1894	24.7	25.0	26.6	28.2	28.0	27.7	27.2	27.3	26.8	26.9	25.6	25.0	26.6
1895	24.7	25.1	26.7	28.3	28.0	27.8	27.5	27.1	26.9	27.5	25.8	25.1	26.7
1896	24.6	25.8	27.2	28.4	27.6	28.0	27.3	26.4	27.2	27.2	26.4	25.3	26.8
1897	25.7	26.3	27.7	29.0	29.4	29.5	27.5	27.1	27.2	27.3	26.8	25.5	27.4
1898	25.5	26.2	26.3	27.9	28.2	27.6	26.7	27.3	27.2	26.9	26.1	25.7	26.8
Mean	25.0	25.4	26.9	28.3	28.5	27.8	27.1	27.1	26.9	26.9	26.1	25.2	26.8

THE NORMAL MONTHLY TEMPERATURES COMPARED WITH THE NORMAL ANNUAL TEMPERATURE.

The greater or less degree with which the normal temperature of the different months of the year increases or diminishes may be clearly seen in the following table, in which we give the difference between the normal mean of each month and the annual mean:

Month.	Monthly mean.	Difference.
	°	°
January	25.0	−1.8
February	25.4	−1.4
March	26.9	+ .1
April	28.3	+1.5
May	28.5	+1.7
June	27.8	+1.0
July	27.1	+ .3
August	27.1	+ .3
September	26.9	+ .1
October	26.9	+ .1
November	26.1	− .7
December	25.2	−1.6
Annual mean	26.8	....

EXTREME ANNUAL MEANS—COMPARISON BETWEEN THE NORMAL AND THE EXTREME MEANS OF EACH MONTH.

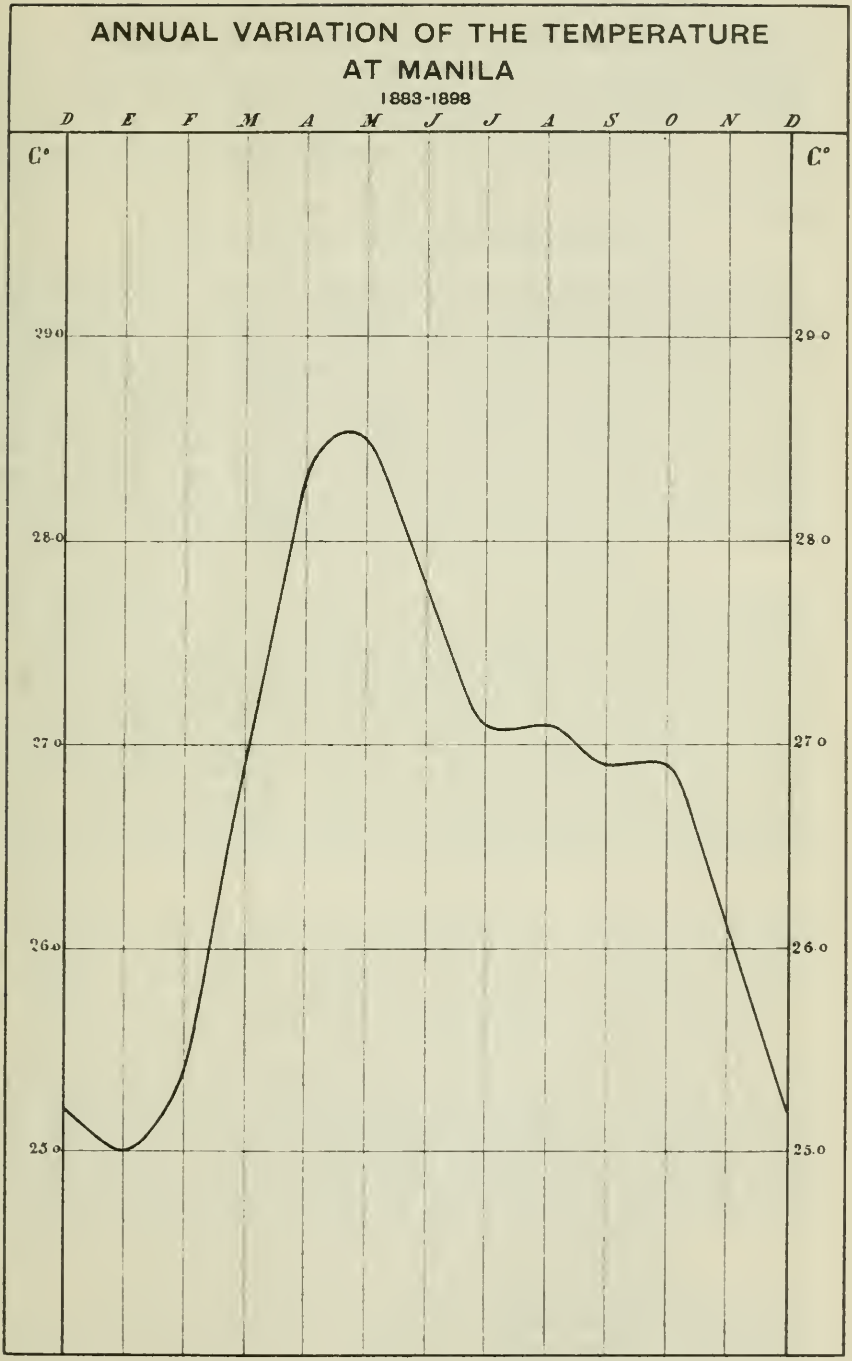
Now, if we compare the temperature of some years with that of others, we find very little difference between the mean annual temperatures, whose extremes, 26.2° in 1884 and 27.4° in 1889 and 1897, only differ by 1.2°, as also between the same monthly means.

In order that this may be readily seen, we have arranged the following table, in which we give the extreme differences observed in the period from 1883 to 1898 between the normal temperatures and the means of each month:

Month.	Normal mean.	Maximum positive difference.	Maximum negative difference.
	°	°	°
January	25.0	0.8 (1889)	1.4 (1884)
February	25.4	1.0 (1889)	1.0 (1885)
March	26.9	.8 (1883, 1897)	.8 (1885)
April	28.3	1.1 (1889)	1.0 (1885)
May	28.5	1.8 (1889)	.9 (1896)
June	27.8	1.7 (1897)	.8 (1884)
July	27.1	.4 (1889, 1895, 1897)	1.0 (1888)
August	27.1	.6 (1893)	.7 (1896)
September	26.9	.7 (1885, 1888)	.6 (1887)
October	26.9	.6 (1895)	.8 (1890)
November	26.1	.7 (1897)	.7 (1890)
December	25.2	.8 (1888)	1.1 (1883)

So that the greatest positive difference of the monthly means is 1.8° and the maximum negative difference 1.4°. It is noted, by the way, that the three maximum positive differences were observed in the months of the greatest heat, April, May, and June, and, on the contrary, the two maximum negative differences correspond to the two months that are least hot—January and December.

PLATE VI.



ANNUAL VARIATION OF THE TEMPERATURE AT MANILA

1883-1898

SLIGHT ANNUAL VARIATION OF THE TEMPERATURE.

A mere glance at Table XVI and at the curve that we have traced in Plate VI is sufficient to convince us of the slight annual variation of the temperature in these tropical countries; the difference between the maximum monthly temperature, which is that of May, and the minimum, which is that of January, does not exceed 3.5°.

DIVISION OF THE YEAR INTO THREE GROUPS OF MONTHS ACCORDING TO THEIR HIGHER OR LOWER TEMPERATURE.

Notwithstanding this, the change from the mild temperature proper to the months of December, January, and February, to the excessively hot temperature of April and May can not fail to be sensibly noted. And so, although on account of the distribution of rain two seasons are recognized in the Philippines (one called dry and the other wet or rainy, as we shall see in the proper place, with regard at the same time to the temperature) some authors also divide the year into three seasons, which they call dry and temperate the first, hot and dry the second, and wet and temperate the third. In corroboration of this see what is said in the Official Guide of the Philippines[1] regarding the general characteristics of the climate of this archipelago:

> As the archipelago is wholly situated within the tropic zone, it has the climate which characterizes the countries which are found in the same position. The high and uniform temperature which the thermometer registers throughout the year is the chief reason which makes it disagreeable and wearisome to live in this region, and which produces in the natives the laziness and inertia which characterizes them, and a sensible prostration of forces in the Europeans who reside for some years in the country. But this uniformity is not to be taken in an absolute manner; for there are three well-defined seasons in the year, of which the first, temperate and dry, usually includes the months of December and January and part of November and February; another, excessively hot and dry, embraces the months of March, April, and May, and the last, finally, temperate and wet, extends from June to October, inclusive; this would be much hotter if the almost constant and abundant aqueous precipitation which takes place in those months did not come to refresh the temperature.

This division, so far as the annual distribution of rain is concerned, or, in other words, the dry and wet or rainy seasons, can by no means be applied to the whole archipelago, but only to the interior and to the western coasts, as we shall see in Chapter V. This same fact is duly noted in the place cited of the Official Guide in these words:

> It must be stated that this refers only to the interior of the archipelago and to the western coasts of the same. This is not the case on the eastern coasts, because the season which we call here temperate and dry is distinguished there by much precipitation, caused by winds from the north, both by condensing the great mass of vapor rising from the ocean as well as by meeting and mingling with winds from the south, which also are bearing a great quantity of evaporated water on account of the vast sea surface they have passed over; and the last, which we call hot and wet, is far from being on that coast as wet as on the western, because the winds have already precipitated on this coast a great quantity of the vapor they contained.

Now, therefore, overlooking here the annual distribution of rains and only paying attention to the variation of the temperature, such as presented to us by the curve of Plate VI, it appears that, with respect to Manila, the twelve months of the year could be divided into the three following groups: The first would comprise the months of temperature that we could almost call temperate, whose monthly means oscillate between 25° and 26.5°; these are the months of November, December, January, and February. In the second we would include the months of excessively hot temperature, whose monthly means range between 27.5° and 28.5°, or the months of April, May, and June. Finally, we include in the third group the other months of intermediate temperature—that is to say, not as mild as the months of the first group nor as excessively hot as the temperature of the second group—whose monthly means are not less than 26.5° nor greater than 27.5°; consequently there are included in this group the month of March, which is between the coolest and the hottest months, and those of July, August, September, and October, also intervening on the opposite side between the same two extreme seasons.

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[1] See Official Guide of the Philippines, year 1898, page 114.

With this it is seen that we differ considerably from what is said in the Official Guide in the place cited a short time ago. But this has appeared necessary to us, because, according to the results obtained with the observations of these last years, which are much more accurate than those of previous years, the month of March can not by any means be included among the months of excessive heat, because the mean which corresponds to it is considerably less than that of June, even a little less than that of July and August, and the same as that of September and October.

II.—MONTHLY AND ANNUAL ABSOLUTE MAXIMA AND MINIMA OF THE TEMPERATURE OF THE AIR IN MANILA.

In the two Tables XVII and XVIII we include the monthly and annual absolute maxima and minima registered in this observatory during the whole period from 1883 to 1898, adding at the foot of each table the respective mean values of said maxima and minima.

TABLE XVII.—*Monthly and annual absolute maxima of the temperature of the air in Manila during the period from 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual maximum.
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
1883	33.2	34.1	34.8	35.8	35.8	33.9	33.6	33.3	33.2	32.3	32.5	31.7	35.8
1884	30.5	31.4	32.5	34.1	35.2	33.4	31.8	32.2	32.0	31.9	32.9	31.1	35.2
1885	30.6	32.1	33.9	34.0	35.7	35.6	33.1	31.8	33.3	33.3	32.1	32.3	35.7
1886	31.8	32.9	33.2	35.5	34.9	34.4	33.3	33.3	32.9	33.4	33.4	31.7	35.5
1887	32.1	32.8	33.7	35.0	36.0	35.0	33.2	33.8	32.4	32.7	32.9	32.7	36.0
1888	32.0	33.8	35.3	35.8	36.7	34.4	33.0	33.4	34.2	33.7	32.4	33.3	36.7
1889	33.0	33.8	35.0	37.2	37.8	35.0	33.5	33.9	34.2	33.1	33.1	31.4	37.8
1890	32.3	32.8	34.8	35.6	35.7	34.7	33.1	33.3	33.2	32.2	32.2	32.1	35.7
1891	31.4	32.5	33.7	35.4	37.7	33.8	32.8	31.1	32.3	34.9	32.9	31.6	37.7
1892	32.3	35.4	34.0	35.2	36.9	36.0	33.4	34.6	32.1	33.3	32.2	31.1	36.9
1893	31.7	34.4	35.5	36.1	35.7	35.4	33.8	33.7	32.2	31.7	33.2	31.2	36.1
1894	31.7	32.4	34.1	35.6	35.4	34.9	34.9	33.8	33.2	33.9	31.7	32.2	35.6
1895	33.0	33.7	35.4	36.2	35.4	36.1	33.9	33.4	34.0	34.1	32.9	32.3	36.2
1896	32.3	32.9	35.0	36.2	35.0	35.3	34.4	32.1	33.3	34.4	32.7	33.2	36.2
1897	33.9	33.2	34.6	35.4	37.2	35.6	34.1	33.5	33.1	32.9	33.3	31.9	37.2
1898	32.1	32.5	33.6	34.9	35.4	33.8	32.7	31.7	34.3	33.2	32.8	31.7	35.4
Mean	32.1	33.2	34.3	35.5	36.0	34.8	33.4	33.1	33.1	33.2	32.7	32.0	36.2

TABLE XVIII.—*Monthly and annual absolute minima of the temperature of the air in Manila during the period from 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual minimum.
	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	°
1883	18.3	19.2	20.1	22.8	22.6	22.8	22.8	22.8	22.8	22.2	21.0	16.7	16.7
1884	18.0	17.9	19.9	21.0	23.1	22.8	21.6	22.2	21.9	21.8	19.0	17.5	17.5
1885	18.6	18.3	17.4	20.6	22.2	23.1	22.9	22.2	22.9	22.4	21.0	18.4	17.4
1886	16.7	17.6	18.9	20.7	22.8	22.8	22.4	21.9	22.9	21.9	20.7	19.2	16.7
1887	17.2	17.2	19.9	21.1	22.3	21.9	22.8	22.2	22.2	20.6	21.2	18.3	17.2
1888	17.7	16.1	19.3	21.4	22.8	22.8	22.3	23.2	23.1	21.7	21.1	17.7	16.1
1889	18.2	20.0	19.4	21.1	23.3	22.8	22.8	22.2	22.8	22.9	21.4	19.4	18.2
1890	17.8	18.2	20.5	21.9	22.9	22.2	22.4	23.3	22.5	20.4	18.3	17.8	17.8
1891	17.8	17.2	18.3	21.0	22.6	22.2	21.1	22.7	22.2	21.2	21.1	19.3	17.2
1892	19.2	18.6	20.7	20.7	21.7	22.9	22.5	22.1	21.8	21.7	19.2	15.7	15.7
1893	17.2	17.8	18.9	20.4	22.5	21.7	22.8	23.1	21.7	21.1	20.8	19.2	17.2
1894	17.2	17.9	18.4	18.9	22.3	22.8	22.9	22.8	22.5	21.6	18.9	19.3	17.2
1895	18.3	18.2	18.2	21.0	22.9	21.6	21.6	22.6	21.4	20.6	18.8	18.3	18.2
1896	17.3	18.3	18.3	19.8	22.9	23.4	22.8	20.6	23.3	21.8	21.2	18.7	17.3
1897	17.9	18.7	19.9	22.7	23.9	23.4	22.4	22.3	23.1	22.2	21.7	20.1	17.9
1898	17.1	18.4	19.8	21.0	23.0	22.9	22.9	22.5	22.5	22.7	21.7	19.4	17.1
Mean	17.8	18.1	19.2	21.0	22.7	22.6	22.4	22.4	22.5	21.7	20.4	18.4	17.2

MEAN VALUES OF THE ANNUAL AND MONTHLY ABSOLUTE MAXIMA AND MINIMA.

According to the data shown by these tables, the difference between the means of the absolute maxima and minima is 19°. The maxima and minima means of the monthly absolute maxima are those of May and December, differing only by 4°.

The maxima and minima means of the monthly absolute minima correspond to the months of May and January, the difference being 4.9°.

ABSOLUTE MAXIMA AND MINIMA OF THE WHOLE PERIOD FROM 1883 TO 1898.

The absolute maxima for the whole period we are studying was 37.8°, registered the 23d of May, 1889, the absolute maxima of the year 1891, 37.7°, being very near it, which was observed on the 21st of May. The absolute minima of the same period was 15.7°, and corresponds to the 31st day of December, 1892. Therefore the difference between the absolute maxima and minima of these sixteen last years is 22.1°.

MONTHLY ABSOLUTE MAXIMA AND MINIMA OF THE WHOLE PERIOD.

The monthly absolute maxima and minima for the whole period may be seen in the following table:

Month.	Maximum.	Minimum
	°	°
January	33.9 (1897)	16.7 (1886)
February	35.4 (1892)	16.1 (1888)
March	35.5 (1893)	17.4 (1885)
April	37.2 (1889)	18.9 (1894)
May	37.8 (1889)	21.7 (1892)
June	36.1 (1895)	21.6 (1895)
July	34.9 (1894)	21.1 (1891)
August	34.6 (1892)	20.6 (1896)
September	34.3 (1898)	21.4 (1895)
October	34.9 (1891)	20.4 (1890)
November	33.4 (1886)	18.3 (1890)
December	33.3 (1888)	15.7 (1892)

DISTRIBUTION OF THE ANNUAL ABSOLUTE MAXIMA AND MINIMA IN THE DIFFERENT MONTHS OF THE YEAR.

In the following table we give, distributed among the different months of the year, the annual absolute maxima and minima of the sixteen years included in the period from 1883 to 1898:

Maxima:	
April	6
May	11
Minima:	
January	9
February	4
March	2
December	4

Naturally the annual absolute maxima have always taken place in the hottest months, which are April and May, and the absolute minima in the coolest, which are December, January, and February. And although it is true that we also find two minima registered in the month of March, still they were observed in the first days of that month, which yet share in the thermic conditions of the month of February. This fact, which we do no more than to intimate, again confirms us in the idea expressed in the preceding paragraph, that the month of March can not be counted among the hottest months, as supposed in the Official Guide of the Philippines.

III.—MONTHLY MEANS OF THE DAILY MAXIMA AND MINIMA OF THE TEMPERATURE OF THE AIR IN MANILA—MEAN VALUES OF THE DAILY OSCILLATION.

From the absolute maxima and minima of all the days of the month and for the whole period from 1885 to 1898 we have deducted the monthly means, which we include in the two tables, XIX and XX. The difference between the values of these two tables, or between the maximum and minimum monthly means, will give us the monthly mean oscillation, as may be seen in Table XXI.

TABLE XIX.—*Monthly means of the absolute maxima of the temperature of the air in Manila during the period from 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1885	28.8	29.4	31.2	32.3	33.4	32.8	30.3	30.2	31.3	31.6	30.4	29.8	31.0
1886	29.5	29.5	31.6	33.3	33.1	31.7	31.2	31.3	30.5	30.7	30.1	28.7	30.9
1887	30.2	30.3	31.8	32.4	32.4	31.8	30.1	31.4	29.2	30.5	29.9	30.7	30.9
1888	29.6	31.0	33.2	34.4	34.3	31.4	29.0	30.1	31.7	31.0	30.9	30.6	31.4
1889	30.8	31.6	33.2	35.1	35.8	33.2	31.7	31.0	31.7	31.1	30.2	28.4	32.0
1890	30.5	31.1	32.9	33.1	32.9	31.7	30.7	31.4	29.6	29.8	29.6	29.6	31.1
1891	29.0	30.0	32.1	33.9	35.0	31.2	29.8	29.6	29.6	32.1	30.4	29.5	31.0
1892	29.5	31.4	32.4	33.5	33.9	32.9	30.9	31.4	29.8	30.9	29.7	29.2	31.3
1893	29.1	31.0	31.8	33.9	32.1	32.5	30.9	30.8	29.7	30.2	29.6	29.3	30.9
1894	29.7	29.9	31.7	34.0	33.0	31.9	30.8	30.9	30.3	30.9	29.8	29.0	31.0
1895	29.8	30.5	32.1	33.5	32.0	32.2	31.6	30.8	29.9	32.2	30.4	30.0	31.3
1896	29.9	31.6	33.0	33.8	31.3	31.8	30.9	29.1	30.5	31.0	31.5	30.5	31.2
1897	30.9	31.6	32.6	34.0	34.1	33.4	31.2	30.5	31.3	31.0	31.0	29.6	31.8
1898	29.8	30.9	30.6	32.5	32.5	31.2	30.4	29.7	31.4	30.6	29.4	29.9	30.7
Mean	29.8	30.7	32.2	33.6	33.3	32.1	30.7	30.6	30.5	31.0	30.2	29.6	31.2

TABLE XX.—*Monthly means of the monthly absolute minima of the temperature of the air in Manila during the period from 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1885	20.5	20.0	21.4	23.0	24.2	24.6	24.1	24.0	24.0	23.6	23.1	21.4	22.8
1886	21.1	20.3	21.4	24.0	24.6	24.1	23.8	23.8	24.1	23.5	22.1	21.7	22.9
1887	20.8	20.5	22.5	23.2	23.8	23.8	24.3	23.7	23.6	22.9	22.9	21.8	22.8
1888	20.6	19.5	22.4	23.0	24.2	24.3	23.7	23.7	23.9	23.4	22.6	21.9	22.8
1889	21.4	21.6	22.1	23.8	24.9	24.7	24.1	24.0	24.0	23.8	23.4	22.0	23.3
1890	21.5	21.2	22.2	23.5	23.9	23.7	23.8	23.6	23.8	23.1	21.7	20.8	22.7
1891	20.7	19.9	21.4	23.3	24.6	23.9	23.7	23.8	23.9	23.2	22.8	22.2	22.8
1892	21.6	21.3	22.5	22.8	24.1	24.0	24.0	23.3	23.7	23.6	22.4	21.6	22.9
1893	19.5	20.1	21.5	23.2	24.1	23.7	24.0	24.2	23.4	23.2	22.5	22.0	22.6
1894	20.1	20.6	21.9	23.0	23.8	24.0	23.8	24.0	24.7	23.3	22.0	21.5	22.7
1895	20.2	20.2	21.8	23.2	24.4	24.3	23.7	23.8	24.0	23.3	21.9	20.9	22.6
1896	19.8	20.6	22.0	22.7	24.3	24.5	24.1	23.8	24.0	23.9	22.2	20.7	22.7
1897	20.7	21.2	22.8	24.1	25.2	25.3	24.0	24.1	24.1	24.0	23 2	22.3	23.4
1898	21.7	21.6	22.5	23.3	24.0	24.3	23.6	24.3	23.5	23.7	23.2	22.0	23.1
Mean	20.7	20.6	22.0	23.3	24.3	24.2	23.9	23.9	23.9	23.5	22.6	21.6	22.9

TABLE XXI.—*Mean monthly oscillation of the temperature of the air in Manila during the period from 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1885	8.3	9.4	9.8	9.3	9.2	8.2	6.2	6.2	7.3	8.0	7.3	8.4	8.1
1886	8.4	9.2	10.2	9.3	8.5	7.6	7.4	7.5	6.4	7.2	7.3	7.0	8.0
1887	9.4	9.8	9.3	9.2	8.6	8.0	5.8	7.7	5.6	7.6	7.0	8.9	8.1
1888	9.0	11.5	10.8	11.4	10.1	7.1	5.3	6.4	7.8	7.6	8.3	8.7	8.6
1889	9.4	10.0	11.1	11.3	10.9	8.5	7.6	7.0	7.7	7.3	6.8	6.4	8.7
1890	9.0	9.9	10.7	9.6	9.0	8.0	6.9	7.8	5.8	6.7	7.9	8.8	8.4
1891	8.3	10.1	10.7	10.6	10.4	7.3	6.1	5.8	5.7	8.9	7.6	7.3	8.2
1892	7.9	10.1	9.9	10.7	9.8	8.9	6.9	8.1	6.1	7.3	7.3	7.6	8.4
1893	9.6	10.9	10.3	10.7	8.0	8.8	6.9	6.6	6.3	7.0	7.1	7.3	8.3
1894	9.6	9.3	9.8	11.0	9.2	7.9	7.0	6.9	5.6	7.6	7.8	7.5	8.3
1895	9.6	10.3	10.3	10.3	7.6	7.9	7.9	7.0	5.9	8.9	8.5	9.1	8.6
1896	10.1	11.0	11.0	11.1	7.0	7.3	6.8	5.3	6.5	7.1	9.3	9.8	8.5
1897	10.2	10.4	9.8	9.9	8.9	8.1	7.2	6.4	7.2	7.0	7.8	7.3	8.4
1898	8.1	9.3	8.1	9.2	8.5	6.9	6.8	5.4	7.9	6.9	6.2	7.9	7.6
Mean	9.1	10.1	10.1	10.3	9.0	7.9	6.8	6.7	6.6	7.5	7.6	8.0	8.3

RELATION BETWEEN THE DIFFERENT MONTHLY MEANS AND THE MAXIMUM TEMPERATURES.

By examining the mean values of the monthly absolute maxima given in Table XIX we find that the highest means, 33.6° and 33.3°, are those of April and May, and the least, 29.6° and 29.8°, those of December and January; the means of the remaining months oscillate between 30.2° and 32.2°. It is noted that the means of the absolute maxima of March and June are almost identical, and even that of the former somewhat higher than that of June; but, on the contrary, as is seen in Table XX, the mean of the minima corresponding to the month of March is 2.2° less than that of June, and this is the reason why, in spite of the absolute maxima of both months being so similar, still the monthly mean of June is considerably higher than the monthly mean of March, as we have stated in Paragraph I of this chapter. The rains, which begin to be frequent in the month of June, produce a notable diminution in the thermic oscillation, and prevent the temperature of the air reaching that degree of heat which it would doubtless attain in that month and even in the two or three following if it were not for the state of cloudiness and the abundant aqueous precipitation belonging to that season of the year. To this same fact we attribute the rise which is observed in the mean value of the October maxima, if compared with that of the three preceding months, because in that month, being as it is the last of the so-called rainy season, the frequency of the rains is already much less, and therefore the clearer state of the atmosphere, especially during the hottest part of the day, permits the absolute maxima of the temperature to be somewhat higher, whereas, as the oscillation is also greater, the mean of the minima of said month of October comes to 0.4° less than that of July, August, and September; hence it is easily understood how the monthly means of these four months differ so little, as indicated at the beginning of this chapter.

RELATION BETWEEN THE MONTHLY MEANS AND THE MINIMUM TEMPERATURES.

If we note the relation which the monthly means of Table XX bear to each other, we shall see that the least minimum means correspond to the months of February and January and the greatest to May and June. The mean minimums of July, August, and September follow these latter and preserve the same degree of relationship, the mean values of the minimums of the remaining months—October, April, November, March, and December—being less high.

GREATEST MAXIMUM MEAN AND LEAST MINIMUM MEAN IN THE WHOLE PERIOD.

The highest mean maximums of all the period were 35.8°, 35.1°, 35°, corresponding respectively to May and April, 1889, and May, 1891. The least minimum mean, likewise of the whole period, was 19.5°, and corresponds to February, 1888, and January, 1893. Therefore the difference between the two extremes—35.8° and 19.5°—is 16.3°.

IV. MAXIMUM AND MINIMUM MONTHLY AND ANNUAL VARIATIONS OF THE TEMPERATURE OF THE AIR IN MANILA.

The two tables (XXII and XXIII) include respectively the maximum and minimum monthly oscillations of the temperature of the air in Manila during the period of sixteen years, 1883–1898:

TABLE XXII.—*Maximum monthly and annual variations of the temperature of the air in Manila during the period of 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual maximum.
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
1883	12.9	12.9	13.2	13.0	10.9	10.0	9.8	9.4	9.4	10.0	11.0	10.7	13.2
1884	11.3	11.1	11.9	11.8	10.8	9.0	8.6	8.8	9.3	9.3	9.9	10.3	11.9
1885	11.2	13.5	14.3	12.7	11.6	11.0	8.9	9.6	9.4	9.8	10.2	11.1	14.3
1886	11.9	12.0	12.1	12.3	11.1	10.2	10.9	10.0	9.3	11.2	11.8	11.1	12.3
1887	13.4	13.7	12.6	12.5	11.6	11.1	9.3	11.0	8.4	11.1	10.5	12.1	13.7
1888	11.5	13.9	13.4	13.2	13.0	9.4	9.2	8.4	10.9	11.0	10.7	11.3	13.9
1889	13.4	12.5	14.0	14.3	13.0	12.2	10.2	10.6	10.6	9.5	10.8	10.6	14.3
1890	12.8	12.7	13.4	12.8	11.4	11.5	10.2	10.7	9.3	10.7	11.5	12.0	13.4
1891	12.0	14.5	13.6	14.1	12.5	9.7	8.9	7.7	8.8	11.0	10.8	10.6	14.5
1892	12.3	15.0	13.3	13.4	13.2	12.0	10.0	11.5	9.6	10.6	11.4	12.7	15.0
1893	12.7	14.3	13.8	13.0	11.4	11.4	9.8	9.8	8.6	9.7	11.5	10.5	14.3
1894	13.9	13.2	13.5	16.4	12.1	11.0	11.4	10.0	9.7	10.9	10.4	10.3	16.4
1895	14.7	12.9	14.6	13.3	11.4	11.2	10.1	9.4	9.7	11.2	12.2	12.8	14.7
1896	14.0	14.3	14.9	13.7	11.2	10.3	10.0	8.9	9.9	11.0	11.3	13.8	14.9
1897	13.4	12.9	13.4	11.6	12.1	12.1	9.8	9.7	9.3	9.9	10.9	10.9	13.4
1898	13.0	12.9	12.0	12.2	11.6	10.4	9.5	8.9	11.4	9.3	9.6	11.2	13.0
Mean	12.8	13.3	13.4	13.1	11.8	10.8	9.8	9.7	9.6	10.4	10.9	11.4	14.0

TABLE XXIII.—*Minimum monthly and annual variations of the temperature of the air in Manila during the period 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual mean.
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
1883	4.4	6.5	6.7	4.3	2.8	3.9	1.6	3.0	2.1	1.8	1.8	4.6	1.6
1884	4.8	4.5	6.2	5.9	3.2	3.1	2.6	2.8	2.4	5.2	3.4	3.4	2.4
1885	5.2	6.8	5.2	4.4	6.4	3.5	3.4	4.1	2.6	5.9	4.1	6.0	2.6
1886	5.9	6.2	6.9	5.8	5.5	5.0	3.6	2.8	2.4	1.9	4.0	3.0	1.9
1887	4.5	6.6	6.3	4.2	5.5	4.7	3.1	4.0	2.9	2.5	2.7	1.1	2.5
1888	4.9	8.3	7.9	7.7	5.0	2.9	2.5	2.9	5.1	2.6	5.0	2.1	2.1
1889	5.1	7.2	8.1	7.2	7.1	5.6	2.7	3.5	4.3	4.0	2.8	1.2	1.2
1890	6.2	7.1	8.8	4.3	5.8	2.6	1.5	5.4	1.1	2.6	2.9	4.7	1.1
1891	2.5	6.0	6.6	7.4	5.6	2.3	2.6	2.9	3.2	5.6	2.1	3.7	2.1
1892	2.0	6.2	6.3	7.1	7.3	5.3	4.0	4.0	2.7	3.5	3.2	5.1	2.0
1893	5.4	6.8	6.2	6.7	2.2	1.6	2.4	2.8	3.4	2.9	2.2	5.0	1.6
1894	5.4	6.5	5.6	6.5	5.3	3.1	3.6	3.6	2.0	5.5	3.1	5.0	2.0
1895	5.5	6.5	5.9	6.7	2.7	2.9	4.5	4.1	2.5	4.7	4.4	5.0	2.5
1896	5.8	8.0	7.6	6.9	2.9	2.9	4.2	2.7	3.8	2.7	6.0	7.2	2.7
1897	6.2	7.2	4.7	7.9	4.8	4.3	3.9	1.9	2.7	2.4	3.5	3.8	1.9
1898	3.7	2.9	2.2	5.4	3.2	3.5	3.3	2.2	5.6	3.2	1.8	5.5	1.8
Mean	4.8	6.5	6.3	6.2	4.7	3.6	3.1	3.3	3.1	3.6	3.3	4.3	2.0

MEAN MONTHLY VALUES OF THE MAXIMUM VARIATIONS OF THE TEMPERATURE.

According to the result which Table XXII gives us, the highest means of the maximum variations are those of February, March, and April; then follow in diminishing order the means of January, May, December, November, June, and October, and finally those of least amplitude correspond to July, August, and September—that is to say, to the months that are most rainy and have the greatest nebulosity. From December to May, both inclusive, we do not find in the whole period any maximum variation the amplitude of which is less than 10°. On the contrary, from July to September, and especially in the latter month, the maximum oscillations which reach this amplitude are very few in number.

RELATION BETWEEN THE MONTHLY MEANS OF THE MINIMUM OSCILLATIONS.

The relation between the monthly means of the minimum oscillations of temperature is on the whole very similar to what we have indicated for the means of the maximum oscillations. The means of least amplitude are those of July and September; those of August, November, October, June, December, May, and January are somewhat greater and in ascending order; and the means of February, March, and April show the highest values. As it may be said that the most insignificant oscillations, less than 4° and 3°, are always observed on very rainy, or at least very cloudy, days, and these days may occur in any of the months of the year; hence in almost all, even those which are usually clearest and have the greatest thermic oscillation, we may find here and there a minimum oscillation less than 3°. Only in the month of April, to which corresponds, as will be seen in the proper place, the least nebulosity, we do not find in the whole period of sixteen years any oscillation whose amplitude has not exceeded 4°.

MAXIMUM AND MINIMUM OSCILLATIONS OF THE WHOLE PERIOD. EXTREME VALUES OF THE MAXIMUM AND MINIMUM ANNUAL OSCILLATIONS.

The maximum and minimum oscillations for the whole period from 1883 to 1898 are of 16.4° and 1.1°, registered, respectively, the 9th of April, 1894, and the 27th of September, 1890. The extreme values of the maximum annual oscillations are 16.4° and 11.9°, corresponding to the years 1894 and 1884. The minimum annual oscillations are comprised between 1.1° and 2.7°, observed in 1890 and 1896.

DISTRIBUTION OF THE ANNUAL MAXIMA AND MINIMA IN THE DIFFERENT MONTHS OF THE YEAR.

In the following table we give the annual maximum and minimum oscillations distributed among the different months of the year:

Maxima:	
January	3
February	5
March	6
April	3
Minima:	
January	1
June	1
July	1
August	2
September	5
October	3
November	2
December	2

The greatest frequency of annual maximum oscillations is observed in the months of February and March, and that of the minimum in the month of September.

MAXIMUM AND MINIMUM OSCILLATIONS FOR THE ENTIRE PERIOD.

The maximum and minimum monthly oscillations for the entire period may be seen below.

Month.	Maximum oscillation.	Minimum oscillation.
	° C.	° C.
January	13.9 (1894)	2.0 (1892)
February	15.0 (1892)	2.9 (1898)
March	14.9 (1896)	2.2 (1898)
April	16.4 (1894)	4.2 (1887)
May	13.2 (1892)	2.2 (1893)
June	12.2 (1889)	1.6 (1893)
July	11.4 (1894)	1.5 (1890)
August	11.5 (1892)	1.9 (1897)
September	11.4 (1898)	1.1 (1890)
October	11.2 (1886, 1895)	1.8 (1883)
November	12.2 (1895)	1.8 (1883, 1898)
December	13.8 (1896)	1.2 (1889)

Without doubt the minimum oscillation corresponding to the month of December, 1889, in this table will attract attention, but it should be noted that this was observed on a very cloudy day when there were copious rains, due to the influence of a typhoon, which, proceeding from the Pacific, divided itself into two branches on reaching the archipelago, one passing by the south, not very far from Manila, and the other advancing toward the north in the Pacific, to the east of Luzon.

DAILY VARIATION OF THE TEMPERATURE OF THE AIR IN MANILA.

The daily monthly course of the temperature of the air in Manila may be seen in Table XXIV, which includes the hourly means of each month, taken from the period 1889–1898. These same mean monthly values have been used in tracing the twelve curves of Plates VII and VIII.

TABLE XXIV.—*Mean hourly, monthly, annual, and semiannual variations of the temperature of the air during the period 1889 to 1898.*

FORENOON.

Month.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
January	23.1	22.7	22.4	22.0	21.7	21.5	21.7	23.4	25.7	26.7	27.3	27.9
February	23.5	23.1	22.7	22.3	21.8	21.6	22.0	24.2	26.5	27.3	28.0	28.5
March	24.6	24.2	23.8	23.4	23.0	22.8	23.7	26.1	28.1	28.6	29.1	29.8
April	25.9	25.5	25.0	24.5	24.1	23.9	25.7	28.3	29.5	30.0	30.6	31.3
May	26.4	26.1	25.7	25.4	25.1	25.2	27.0	29.0	30.0	30.4	31.0	31.5
June	26.0	25.8	25.5	25.3	25.1	25.2	26.4	28.2	29.3	30.0	30.4	30.7
July	25.6	25.4	25.2	25.0	24.8	24.8	25.8	27.2	28.2	28.9	29.3	29.6
August	25.6	25.4	25.2	25.0	24.9	24.8	25.7	27.0	28.0	28.6	29.1	29.3
September	25.5	25.3	25.2	25.0	24.9	24.8	25.7	26.9	27.9	28.6	28.9	29.2
October	25.2	25.0	24.7	24.5	24.4	24.3	25.2	26.7	28.0	28.8	29.3	29.7
November	24.4	24.2	23.9	23.6	23.5	23.3	24.0	25.4	26.8	27.8	28.4	28.7
December	23.5	23.3	23.0	22.8	22.5	22.3	22.8	24.2	25.9	26.9	27.7	28.0
Mean	24.94	24.67	24.36	24.07	23.82	23.71	24.64	26.38	27.83	28.55	29.09	29.52
Mean, November–May	24.49	24.16	23.79	23.43	23.10	22.94	23.84	25.80	27.50	28.24	28.87	29.39
Mean, June–October	25.58	25.38	25.16	24.96	24.82	24.78	25.76	27.20	28.28	28.98	29.40	29.70

AFTERNOON.

Month.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Mean.
	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.	° C.
January	28.4	28.9	29.1	28.7	27.8	26.6	25.5	24.9	24.5	24.1	23.8	23.4	25.1
February	29.4	29.9	30.1	29.8	29.0	27.6	26.4	25.7	25.1	24.7	24.4	24.0	25.7
March	30.6	31.2	31.4	31.0	30.2	28.8	27.7	26.9	26.3	25.9	25.5	25.1	27.0
April	32.2	32.7	32.8	32.4	31.5	30.1	29.0	28.3	27.7	27.2	26.9	26.4	28.4
May	32.0	32.1	31.8	31.2	30.5	29.6	28.9	28.4	27.9	27.5	27.1	26.8	28.6
June	31.0	31.1	30.8	30.4	29.7	28.9	28.2	27.7	27.3	26.9	26.6	26.3	28.0
July	29.8	29.8	29.6	29.1	28.5	27.9	27.3	27.0	26.6	26.2	26.0	25.8	27.2
August	29.6	29.5	29.2	28.7	28.3	27.7	27.2	26.8	26.5	26.3	26.0	25.8	27.1
September	29.4	29.3	29.0	28.5	28.0	27.4	27.0	26.7	26.3	26.1	25.9	25.6	26.9
October	29.9	29.9	29.6	29.2	28.5	27.7	27.1	26.8	26.3	26.0	25.7	25.5	27.0
November	29.0	29.0	28.8	28.4	27.6	26.8	26.1	25.7	25.4	25.1	24.8	24.6	26.1
December	28.4	28.5	28.4	28.0	27.2	26.1	25.4	25.0	24.5	24.3	24.0	23.8	25.3
Mean	29.98	30.16	30.05	29.62	28.90	27.93	27.15	26.66	26.20	25.86	25.56	25.26	26.87
Mean, November–May	30.00	30.33	30.34	29.93	29.11	27.94	27.00	26.41	25.91	25.54	25.21	24.87	26.60
Mean, June–October	29.94	29.92	29.64	29.18	28.60	27.92	27.36	27.00	26.60	26.30	26.04	25.80	27.24

DAILY OSCILLATION OF THE TEMPERATURE OF THE AIR.

In the following table, as well as in the twelve curves, the only oscillation which is ordinarily observed in the daily variation of the temperature of the air is seen at once, the minimum taking place at 5 or 6 in the morning and the maximum from 1 to 3 in the afternoon.

The laws which govern this oscillation will be readily observed by means of the following table, in which we give the hours of the minima and maxima and the amount of the mean oscillation of each month, data which we take from the same Table XXIV:

Months.	Hours of—		Amplitude of oscillation.
	Minimum.	Maximum.	
			°
January	6 a.m.	3 p.m.	7.6
February	6 a.m.	3 p.m.	8.5
March	6 a.m.	3 p.m.	8.6
April	6 a.m.	3 p.m.	8.9
May	5 a.m.	2 p.m.	7.0
June	5 a.m.	2 p.m.	6.0
July	5 a.m. 6 a.m.	1 p.m. 2 p.m.	5.0
August	6 a.m.	1 p.m.	4.8
September	6 a.m.	1 p.m.	4.6
October	6 a.m.	1 p.m. 2 p.m.	5.6
November	6 a.m.	1 p.m. 2 p.m.	5.7
December	6 a.m.	2 p.m.	6.2
Mean			6.5

LAWS OF THIS DAILY OSCILLATION IN THE DIFFERENT MONTHS OF THE YEAR.

These conclusions may evidently be deduced from this table:

1. That the months of greatest oscillation, whose mean amplitude is comprised between 7° and 9°, are April, March, February, and January. The greatest mean amplitude is of 8.9° and corresponds to April.

2. That the months of the least oscillation, whose amplitude oscillates between 4° and 5°, are July, August, and September. The minimum mean amplitude of thermic oscillation is 4.6° and corresponds to the month of September.

3. That the months of intermediate oscillation, whose amplitude varies from 5° to 7°, are June, October, November, and December.

4. Hence it follows that what we read in the Official Guide of the Philippines, page 115, can not be admitted in an absolute way, that is to say, that the greatest oscillations are observed in the most temperate months and the least in the hottest months; because it is certain that April is the hottest month after May, and notwithstanding it shows the maximum thermic oscillation. The reason for this greater or lesser oscillation must be sought rather, as we have already indicated, in the state of nebulosity of the atmosphere.

5. In the months of the greatest oscillation—January–April—the minimum corresponds to 6 a. m. and the maximum to 3 p. m.

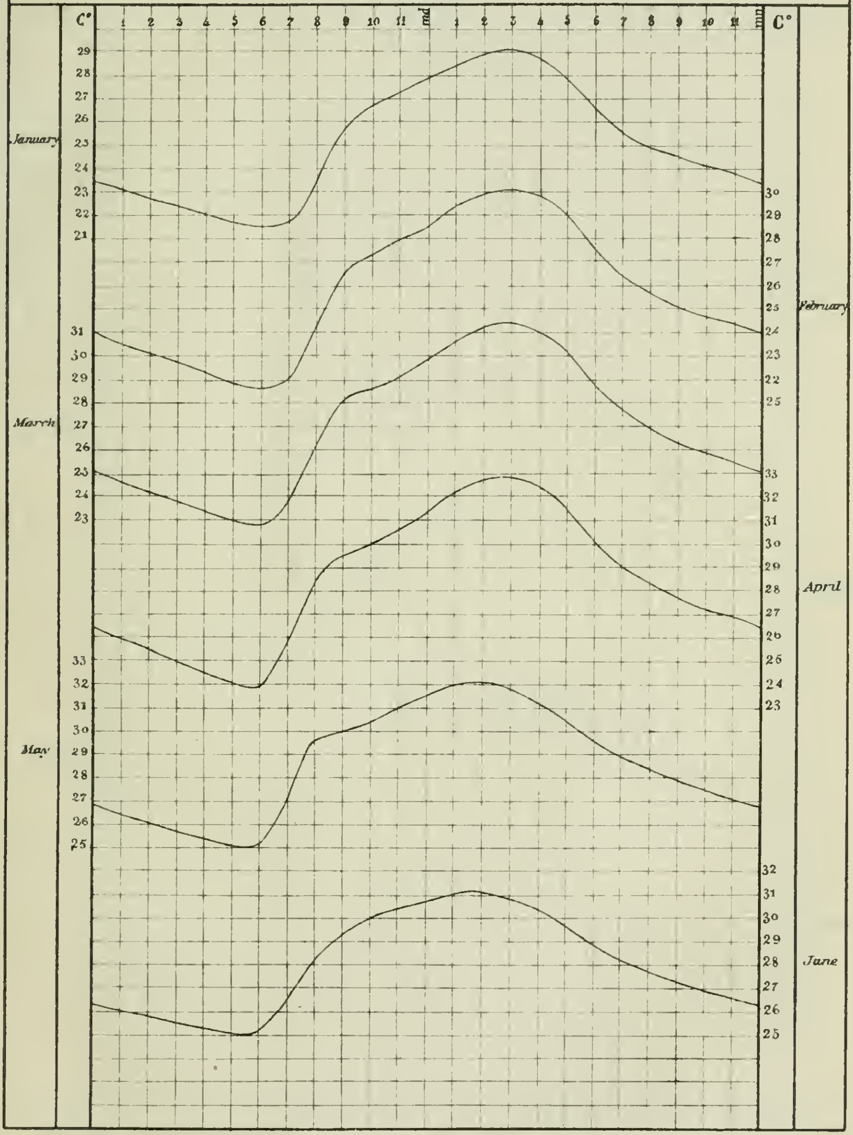
6. In the months of May and June the hour of the minimum as well as that of the maximum is somewhat advanced, the former occurring at 5 a. m. and the latter at 2 p. m.

7. In the month of July the minimum hourly observation corresponds to 5 and 6 in the morning and the maximum to 1 and 2 in the afternoon, which indicates that the hour of the minimum is again retarded, at the same time that the hour of the maximum still advances. In August and September the minimum is already observed at 6 a. m., as in the first months of the year; but the maximum has advanced to 1 p. m.

PLATE VII.

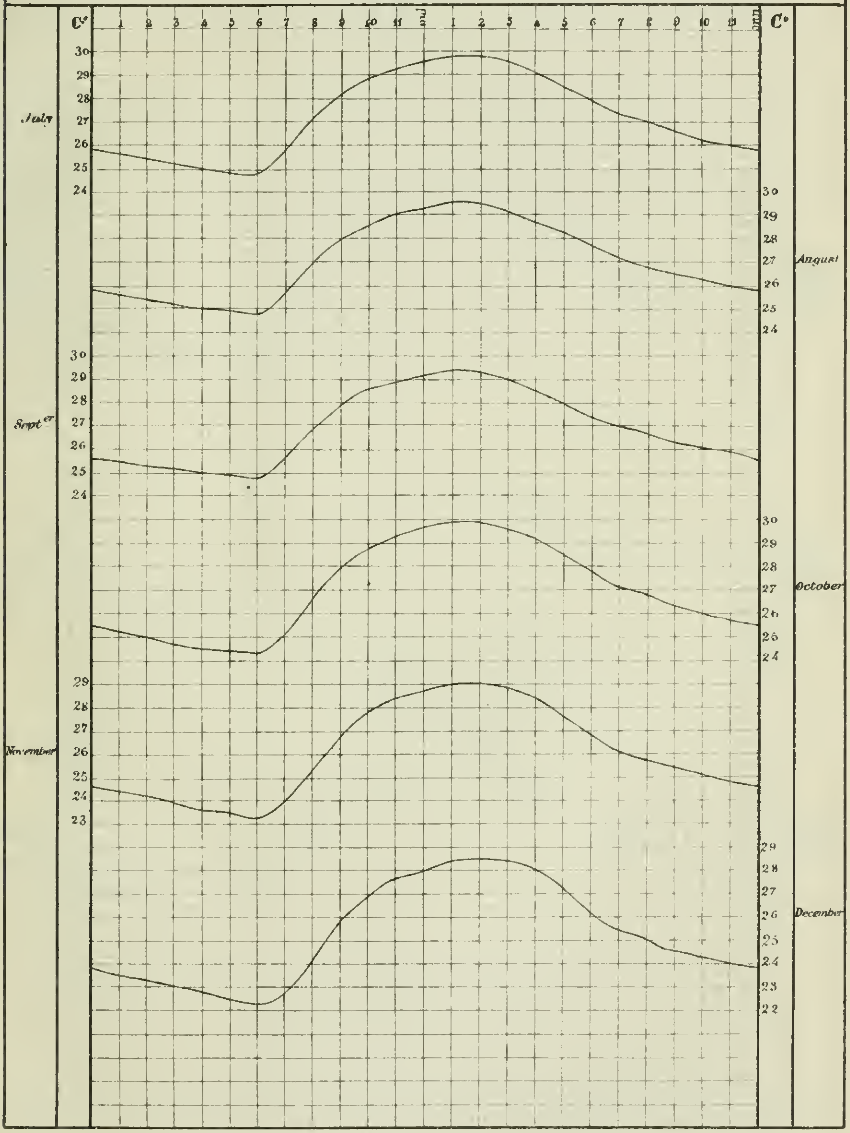
DAILY VARIATION OF THE TEMPERATURE AT MANILA

1889-1898



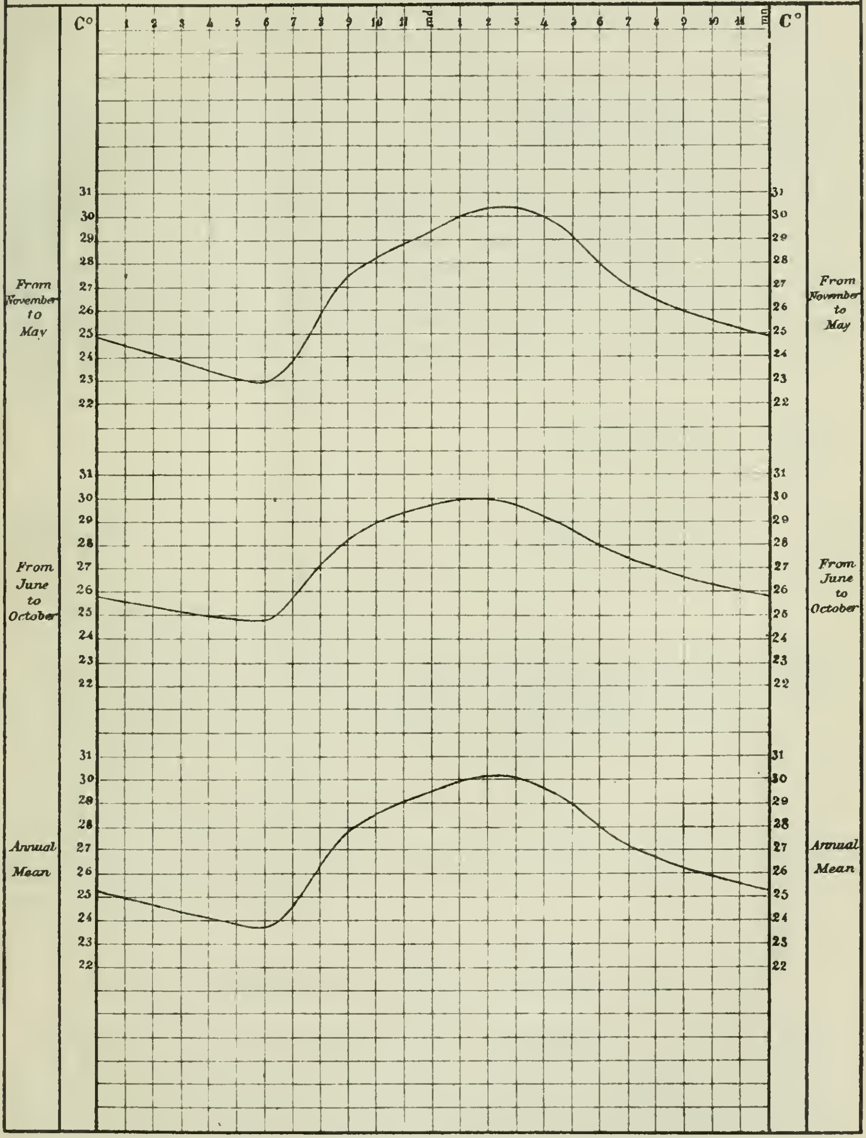
DAILY VARIATION OF THE TEMPERATURE AT MANILA

1889-1898



DAILY VARIATION OF THE TEMPERATURE AT MANILA

1889-1898



8. From October to December, both inclusive, the minimum still takes place at 6 a. m., but the maximum is again somewhat retarded, especially in December; in October and November the hourly maximum observation is that of 1 and that of 2 p. m., but in December it is already only that of 2 p. m.

MEAN DAILY OSCILLATION OF THE TEMPERATURE, ANNUAL AND SEMIANNUAL.

At the foot of Table XXIV we give not only the hourly annual variation of the temperature of the air in Manila but also the hourly semiannual variation, for which purpose we have considered the year as divided into two periods—June–October and November–May—a division which we think very apropos for our object, since the first includes the months of most copious rains and greatest nebulosity, and the second, on the contrary, the least cloudy months and with the least aqueous precipitation. These mean annual and semiannual values may be seen graphically represented in the three curves of Plate IX. In the adjoining table we give the amplitude of the oscillation and the hours of the maximum and minimum, such as they appear in these same annual and semiannual means:

	Hours of—		Amplitude of oscillation.
	Minimum.	Maximum.	
			°
Annual	6 a.m	2 p.m	6.45
November–May	6 a.m	3 p.m	7.40
June–October	6 a.m	1 p.m	5.16

From these data we conclude:

1. That the mean annual oscillation is 6.45°.
2. That the mean oscillation for the period from November to May is 7.40°, and that of the other period from June to October, 5.16°. The difference between the oscillations of both periods is 2.24°.
3. That the mean annual hours of the daily minima and maxima are respectively 6 a. m. and 2 p. m.
4. That in the two periods the mean minimum of the hourly observations corresponds to 6 a. m.
5. That the maximum of the mean result of the period from November to May corresponds to 3 p. m., and that of the other period from June to October to 1 p. m.

PROBABLE CAUSE OF THE ADVANCE OF THE HOUR OF MINIMUM OR MAXIMUM TEMPERATURE IN SOME MONTHS OF THE YEAR.

It is known that the minimum daily temperature is usually registered everywhere about sunrise; and as in these countries within the Tropics the position of the sun and the length of the day, and consequently the hour for the rising of said heavenly body differs very little in the different months of the year, hence the hour of minimum temperature is also almost the same in all the months. We have said above that said hour advances a little in the months of May and June; and, indeed, we find that during these two months the sunrise takes place a little earlier than in all the rest.

So far as concerns the advance which is observed in the hours of the maxima from May to December, if compared with those of the first four months—from January to April—we think that principally, and more than to any other cause, it is to be attributed to the state of cloudiness of the atmosphere. As a clear and evident confirmation of this our readers are referred to the study which Father Algué made in the meteorologic reviews of our Monthly Bulletin of 1894 of the mean monthly variation of the temperature of the air in Manila and the actual variation of the clear and of the cloudy days. There were published therein twelve plates, corresponding to the twelve months of the year, in each of which may be seen three curves, which represent, respectively, the mean monthly variation of the temperature deducted from a period of several years, and taking into account for the average, (*a*) all the days of the month, (*b*) only the clear days, and (*c*) only the cloudy days. Now, then, comparing the curve of mean oscillation of the clear days with that of the cloudy days, it is seey that in the latter not only is the amplitude of the oscillation much less, but also in all the months the hour of the daily maximum is notably advanced, whereas it is retarded in the clear days. Thus, we remember having noted sometimes on very clear days that the maximum has not been registered until almost 4 p. m., and even between 4 and 5 p. m., while on very rainy days it sometimes takes place shortly after midday.

Hence, if this is observed in all the months of the year, comparing the oscillation of the cloudy days with that of the clear days, it is readily understood that the mean nebulosity of the different months of the year must have a marked influence on the general oscillation of each month. In Chapter VII it will be told how January, February, March, and April are the clearest months, and in those precisely we have just seen that the hour of maximum temperature is most retarded. On the contrary, the nebulosity is greater in the other months, but especially in August and September; and so also we have noted that the hour of maximum temperature is advanced in them, especially in the two months cited.

THE HOURLY MEANS OF THE TEMPERATURE OF THE AIR COMPARED BETWEEN THEMSELVES AND WITH THE MONTHLY MEANS.

TABLE XXV.—*Difference between the hourly means compared between themselves and between the same hourly means and the monthly means of the temperature of the air in Manila.*

Hours.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1 a.m	—2.0	—2.2	—2.4	—2.5	—2.2	—2.0	—1.6	—1.5	—1.4	—1.8	—1.7	—1.8	—1.93
0-1 a.m	—0.3	—0.5	—0.5	—0.5	—0.4	—0.3	—0.2	—0.2	—0.1	—0.3	—0.2	—0.3	—0.32
2 a.m	—2.4	—2.6	—2.8	—2.9	—2.5	—2.2	—1.8	—1.7	—1.6	—2.0	—1.9	—2.0	—2.20
1-2 a.m	—0.4	—0.4	—0.4	—0.4	—0.3	—0.2	—0.2	—0.2	—0.2	—0.2	—0.2	—0.2	—0.27
3 a.m	—2.7	—3.0	—3.2	—3.4	—2.9	—2.5	—2.0	—1.9	—1.7	—2.3	—2.2	—2.3	—2.51
2-3 a.m	—0.3	—0.4	—0.4	—0.5	—0.4	—0.3	—0.2	—0.2	—0.1	—0.3	—0.3	—0.3	—0.31
4 a.m	—3.1	—3.4	—3.6	—3.9	—3.2	—2.7	—2.2	—2.1	—1.9	—2.5	—2.5	—2.5	—2.80
3-4 a.m	—0.4	—0.4	—0.4	—0.5	—0.3	—0.2	—0.2	—0.2	—0.2	—0.2	—0.3	—0.2	—0.29
5 a.m	—3.4	—3.9	—4.0	—4.3	—3.5	—2.9	—2.4	—2.2	—2.0	—2.6	—2.6	—2.8	—3.05
4-5 a.m	—0.3	—0.5	—0.4	—0.4	—0.2	—0.2	—0.2	—0.1	—0.1	—0.1	—0.1	—0.3	—0.25
6 a.m	—3.6	—4.1	—4.2	—4.5	—3.4	—2.8	—2.4	—2.3	—2.1	—2.7	—2.8	—3.0	—3.16
5-6 a.m	—0.2	—0.2	—0.2	—0.2	—0.1	—0.1	—0.0	—0.1	—0.1	—0.1	—0.2	—0.2	—0.11
7 a.m	—3.4	—3.7	—3.3	—2.7	—1.6	—1.6	—1.4	—1.4	—1.2	—1.8	—2.1	—2.5	—2.23
6-7 a.m	0.2	0.4	0.9	1.8	1.8	1.2	1.0	0.9	0.9	0.9	0.7	0.5	0.93
8 a.m	—1.7	—1.5	—0.9	—0.1	0.4	0.2	0.0	0.1	0.0	—0.3	—0.7	—1.1	—0.49
7-8 a.m	1.7	2.2	2.4	2.6	2.0	1.8	1.4	1.3	1.2	1.5	1.4	1.4	1.74
9 a.m	0.6	0.8	1.1	1.1	1.4	1.3	1.0	0.9	1.0	1.0	0.7	0.6	0.96
8-9 a.m	2.3	2.3	2.0	1.2	1.0	1.1	1.0	1.0	1.0	1.3	1.4	1.7	1.45
10 a.m	1.6	1.6	1.6	1.6	1.8	2.0	1.7	1.5	1.7	1.8	1.7	1.6	1.68
9-10 a.m	1.0	0.8	0.5	0.5	0.4	0.7	0.7	0.6	0.7	0.8	1.0	1.0	0.72
11 a.m	2.2	2.3	2.1	2.2	2.4	2.4	2.1	2.0	2.0	2.3	2.3	2.4	2.22
10-11 a.m	0.6	0.7	0.5	0.6	0.6	0.4	0.4	0.5	0.3	0.5	0.6	0.8	0.54
12 m.d	2.8	2.8	2.8	2.9	2.9	2.7	2.4	2.2	2.3	2.7	2.6	2.7	2.65
11-12 a.m	0.6	0.5	0.7	0.7	0.5	0.3	0.3	0.2	0.3	0.4	0.3	0.3	0.43
1 p.m	3.3	3.7	3.6	3.8	3.4	3.0	2.6	2.5	2.5	2.9	2.9	3.1	3.11
0-1 p.m	0.5	0.9	0.8	0.9	0.5	0.3	0.2	0.3	0.2	0.2	0.3	0.4	0.46
2 p.m	3.8	4.2	4.2	4.3	3.5	3.1	2.6	2.4	2.4	2.9	2.9	3.2	3.29
1-2 p.m	0.5	0.5	0.6	0.5	0.1	0.1	0.0	—0.1	—0.1	0.0	0.0	0.1	0.18
3 p.m	4.0	4.4	4.4	4.4	3.2	2.8	2.4	2.1	2.1	2.6	2.7	3.1	3.18
2-3 p.m	0.2	0.2	0.2	0.1	—0.3	—0.3	—0.2	—0.3	—0.3	—0.3	—0.2	—0.1	—0.11
4 p.m	3.6	4.1	4.0	4.0	2.6	2.4	1.9	1.6	1.6	2.2	2.3	2.7	2.75
3-4 p.m	—0.4	—0.3	—0.4	—0.4	—0.6	—0.4	—0.5	—0.5	—0.5	—0.4	—0.4	—0.4	—0.43
5 p.m	2.7	3.3	3.2	3.1	1.9	1.7	1.3	1.2	1.1	1.5	1.5	1.9	2.03
4-5 p.m	—0.9	—0.8	—0.8	—0.9	—0.7	—0.7	—0.6	—0.4	—0.5	—0.7	—0.8	—0.8	—0.72
6 p.m	1.5	1.9	1.8	1.7	1.0	0.9	0.7	0.6	0.5	0.7	0.7	0.8	1.06
5-6 p.m	—1.2	—1.4	—1.4	—1.4	—0.9	—0.8	—0.6	—0.6	—0.6	—0.3	—0.8	—1.1	—0.97
7 p.m	0.4	0.7	0.7	0.6	0.3	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.28
6-7 p.m	—1.1	—1.2	—1.1	—1.1	—0.7	—0.7	—0.6	—0.5	—0.4	—0.6	—0.7	—0.7	—0.78
8 p.m	—0.2	—0.0	—0.1	—0.1	—0.2	—0.3	—0.2	—0.3	—0.2	—0.2	—0.4	—0.3	—0.21
7-8 p.m	—0.6	—0.7	—0.8	—0.7	—0.5	—0.5	—0.3	—0.4	—0.3	—0.3	—0.4	—0.4	—0.49
9 p.m	—0.6	—0.6	—0.7	—0.7	—0.7	—0.7	—0.6	—0.6	—0.6	—0.7	—0.7	—0.8	—0.67
8-9 p.m	—0.4	—0.6	—0.6	—0.6	—0.5	—0.4	—0.4	—0.3	—0.4	—0.5	—1.1	—0.5	—0.46
10 p.m	—1.0	—1.0	—1.1	—1.2	—1.1	—1.1	—1.0	—0.8	—0.8	—1.0	—1.0	—1.0	—1.61
9-10 p.m	—0.4	—0.4	—0.4	—0.5	—0.4	—0.4	—0.4	—0.2	—0.2	—0.3	—0.3	—0.2	—0.34
11 p.m	—1.3	—1.3	—1.5	—1.5	—1.5	—1.4	—1.2	—1.1	—1.0	—1.3	—1.3	—1.3	—1.31
10-11 p.m	—0.3	—0.3	—0.4	—0.3	—0.4	—0.3	—0.2	—0.3	—0.2	—0.3	—0.3	—0.3	—0.30
12 m.n	—1.7	—1.7	—1.9	—2.0	—1.8	—1.7	—1.4	—1.3	—1.3	—1.5	—1.5	—1.5	—1.61
11-12 p.m	—0.4	—0.4	—0.4	—0.5	—0.3	—0.3	—0.2	—0.2	—0.3	—0.2	—0.2	—0.2	—0.30
Mean	2.2 0.6	2.5 0.7	2.5 0.7	2.5 0.7	2.1 0.6	1.9 0.5	1.5 0.4	1.4 0.4	1.4 0.4	1.7 0.5	1.7 0.5	1.9 0.5	1.93 0.54

Following the same method as heretofore, we have included Table XXV, the differences between each of the hourly means which we have given in Table XXIV and the respective monthly means. In the intermediate lines we complete this study with the difference which results from comparing each one of the hourly, monthly, and annual means with that immediately before it.

A study of this table will not only confirm the conclusions which we have reached in the preceding paragraph, but it will enable us to see readily the hours in which the increase or decrease of the temperature of the air is usually greater or less. In effect, attending principally to the differences between each one of the twenty-four hours and that immediately preceding it, the following conclusions may be deduced, which confirm and complete the laws of the daily variation of the temperature of the air in Manila, briefly outlined in the preceding paragraph.

1. Speaking in general of the whole year, or rather of the result which the hourly annual means give us, we find that the least differences between two consecutive hours are those which correspond to 5 to 6 a. m. and 2 to 3 p. m., which proves that most commonly between those two hours and between these two latter the absolutely daily minima and maxima occur. The difference from 1 to 2 p. m. is even greater, but not very different from that which results from 2 to 3 p. m.; a sufficiently clear indication that, at least in some months of the year, the daily maximum is usually registered before 2 p. m.

2. Speaking also in general of the whole year, the greatest differences are those from 7 to 8 a. m. and 5 to 6 p. m.; approaching the first is the difference from 8 to 9 a. m. and not very different from the second, those from 4 to 5 p. m. and 6 to 7 p. m.

Hence it follows, (*a*) that the most pronounced ascent of temperature usually lasts about two hours, beginning one or two hours after the rising of the sun; and (*b*) that the greatest descent occurs in the neighborhood of the setting of the sun, and usually begins some three hours before sunset, terminating shortly after the sun has hidden its rays below the horizon.

3. From January to July, both inclusive, the least difference of the dawn is that from 5 to 6 a. m. From August to December all the differences of the night and of the dawn are quite uniform between themselves from 9 p. m. to 6 a. m., appearing, on the whole, those from 4 to 5 a. m. and 5 to 6 a. m. a little less in general.

4. The difference from 5 to 6 a. m. in the months of May and June is the least of all those of the dawn, but positive; whence it may be deducted that the minimum in these months must be advanced and take place between 5 and 5.30 a. m., as already seen in the preceding paragraph. In July the difference from 5 to 6 is 0.0; therefore the minimum of this month must be registered in the neighborhood of 5.30 a. m., or even sometimes between 5 and 5.30 and at other times between 5.30 and 6 a. m. In the remaining months the difference between 5 to 6 a. m. is still negative, and consequently indicates that the minimum must be registered in the neighborhood of 6 a. m.

5. In the months from January to April the least difference of the afternoon corresponds to 2 to 3, and in the other months to from 1 to 2, which is due to the advance of the maximum of which we have spoken in the preceding paragraph.

6. The difference from 1 to 2 p. m. is 0.0 in the months of July, October, and November; hence the maximum of said months must be registered at 1.30 p. m., or rather sometimes between 1 and 1.30 and at other times between 1.30 and 2 p. m.

7. The difference from 1 to 2 p. m. is not only the least but negative in the months of August and September, therefore the maximum of these months must be registered somewhat before 1.30 p. m.

8. The most marked increase of temperature is observed from 7 to 9 in the months from January to March and August to December, and from 6 to 8 in the months of April, May, and June. In July the greatest increase is observed from 7 to 8, the difference from 6 to 7 being somewhat less and equal to that from 8 to 9.

9. The greatest afternoon difference and in a negative direction takes place from 5 to 7 in the months of January to April, and from 4 to 6 in the months October, November, and December. In May, June, July, August, and September the greatest negative differences are noted from 3 to 7, the greatest of them being between 5 and 6.

ANNUAL VARIATION OF THE TEMPERATURE OF THE AIR IN DIFFERENT POINTS OF THE ARCHIPELAGO.

METHOD WHICH WE HAVE FOLLOWED TO DETERMINE THE MONTHLY THERMOMETRIC MEANS OF THE TEMPERATURE OF THE AIR IN DIFFERENT STATIONS IN THE PHILIPPINES.

For similar reasons to those heretofore expressed we have thought that the simplest and most suitable manner of finding with sufficient accuracy the monthly means of the temperature of the air in different points of the archipelago, would be to find the averages of the absolute maxima and minima of each day, deduct from them the monthly means and, uniting various years of observation, determine what we might call the normal means of each month; although it must be said that the term of years which we have taken into account for these results being generally short, the means which we shall give can only have a temporary value.

STATIONS WHICH WE HAVE SELECTED IN LUZON, VISAYAS, AND MINDANAO.

The stations which we have selected for this study are: 7 in Luzon, 1 in Visayas, 1 in Mindanao, and 1 in Jolo. In Luzon we have taken Aparri, on the northern coast; Vigan, on the western coast; Daet and Albay, on the eastern coast; and Tuguegarao, Bayombong, and Magalang, in the interior of the island. Not having published in our monthly bulletins up to the present time more temperature data from the meteorological stations of Luzon than the observations of 10 a. m. and 4 p. m., we were obliged to refer to the original reports and pick out one by one the maxima and minima of each day in order to go on deducting from them the monthly averages; hence the motive which induced us to include only said seven stations, overlooking the others, is readily understood, and for only taking into account a few years of observation.

As to the Visayas Islands, we have given preference to the observations of the model farm of La Carlota, partly because they are the most complete we possess, and also because in those taken in the agronomic stations of Iloilo and Cebu we find notable discrepancies which lead us to suppose instrumental errors that are unknown to us.

Of this staton of La Carlota and of that of Aparri, located, respectively, in the center of the Visayas group of islands and at the northern extremity of Luzon, we shall give quite complete statistics of mean monthly temperatures as well as of extreme temperatures.

In this way, as Aparri is distant from Manila, and Manila from La Carlota, some 4° of latitude, we shall be able, by means of the observations of these three points compared between themselves, to form an approximate idea of the thermic conditions of the principal regions of the Archipelago.

For Mindanao and Jolo we have made use of the observations taken for several years in the capitals of both islands by Fathers Baltasar Ferrer and Gaspar Colomer, of the Society of Jesus.

ANNUAL VARIATION OF THE TEMPERATURE IN APARRI AND LA CARLOTA.

Bearing in mind these brief indications, see, in the two following tables (XXVI and XXVII), the mean temperatures of Aparri during the period from 1886 to 1895 and those of La Carlota for the period from 1891 to 1898.

TABLE XXVI.—*Monthly and annual mean of temperature at Aparri, 1886 to 1895.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*
1886	22.6	22.3	24.7	27.0	27.6	28.4	......	27.8	27.5	26.9	24.5	21.8	......
1887	23.8	23.9	24.6	26.3	27.5	28.4	27.9	27.5	27.1	25.8	25.1	23.4	25.9
1888	22.8	23.9	25.5	28.2	28.9	28.7	27.9	28.1	28.1	27.0	26.0	24.7	26.7
1889	24.6	21.4	25.9	28.3	29.0	28.7	28.1	29.0	28.2	28.1	25.8	24.0	27.0
1890	23.6	24.3	25.8	27.2	27.9	28.7	28.4	28.5	27.3	25.4	24.3	24.1	26.3
1891	22.2	23.8	25.3	26.7	29.3	28.5	27.8	27.3	26.7	26.7	25.4	23.6	26.1
1892	22.9	24.7	25.4	26.8	......	......	27.9	27.4	27.1	25.8	25.0	22.4	......
1893	23.1	21.0	25.0	26.5	26.5	27.8	26.8	27.3	27.0	26.0	23.6	23.2	25.6
1894	23.0	23.2	24.6	25.8	27.2	27.9	27.2	27.8	27.1	26.6	24.6	23.5	25.7
1895	22.5	23.0	24.2	25.8	27.0	28.2	27.8	27.5	......	26.1	24.7	23.2	......
Mean	23.1	23.8	25.1	26.9	27.9	28.4	27.8	27.8	27.3	26.4	24.9	23.4	26.2

TABLE XXVII.—*Monthly and annual mean of temperature at La Carlota, 1891 to 1898.*

Years.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*	° *C.*
1891	......	......	......	27.8	28.5	27.5	26.0	25.3	26.5	26.9	26.2	26.3	......
1892	25.8	26.6	27.7	27.7	28.1	27.0	26.6	26.1	26.8	27.2	26.2	25.9	26.8
1893	25.5	25.8	26.4	27.9	27.1	27.1	26.9	26.8	26.4	26.6	26.4	26.2	26.6
1894	25.3	......	26.5	27.0	27.5	27.0	26.1	26.5	25.9	26.7	26.1	26.0	......
1895	25.9	25.9	25.9	27.2	26.9	26.3	26.1	25.5	25.4	26.6	25.5	25.4	26.1
1896	24.7	25.8	26.6	27.4	26.7	26.5	25.7	25.1	26.2	26.4	26.8	26.1	26.2
1897	26.4	26.9	27.0	28.3	28.3	27.7	26.7	26.3	26.2	26.6	26.9	26.3	27.0
1898	25.9	26.8	......	......	......	26.8	26.1	26.3	26.4	26.9	......	......	......
Mean	25.6	26.3	26.7	27.6	27.6	27.0	26.3	26.0	26.2	26.7	26.3	26.0	26.5

Comparing the mean monthly values of Aparri with those of Manila it is deducted that in that station, as it is situated on a higher parallel of latitude, the annual variation of the temperature is greater and the relation which is observed between the same montly means is also somewhat different. In effect, these oscillate between 23.1° and 28.4°, the amplitude of the annual oscillation being therefore 5.3°, whereas in Manila it does not exceed 3.5°. Furthermore, the maximum temperature is not observed in May, but in June; and the means of July and August are almost identical with that of May, and that of September even higher than that of April.

The minimum temperatures occur, as in Manila, in the months of December, January, and February; but are much less, the mean minimum of Aparri, 23.1°, being 1.9° less than that of Manila. On the other hand, the mean maximum, 28.4°, only differs from that of Manila by 0.1°. The annual mean, 26.2°, is surpassed by the annual mean of Manila by 0.6°.

Regarding the thermometric data of La Carlota included in table XXVII, we must state that, not being taken from any official station dependent on this observatory, but on the model farm, or agronomic station established there, we can not be responsible for them, since we are not sufficiently well acquainted with the quality of the instruments,

PLATE X.

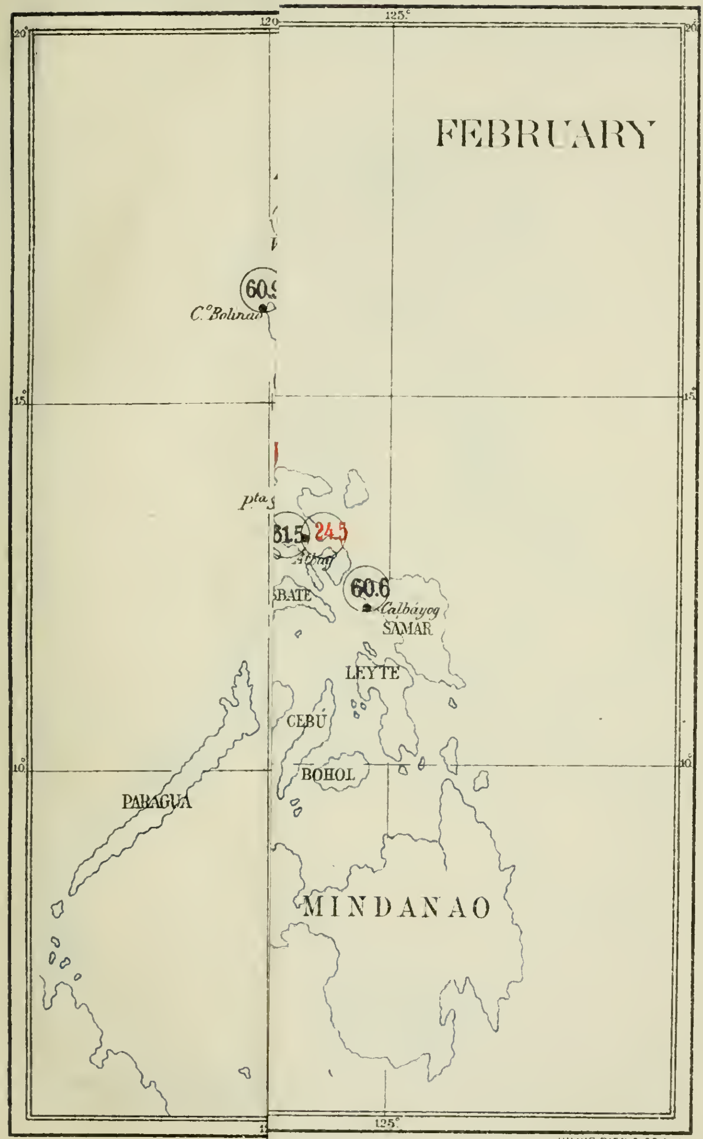


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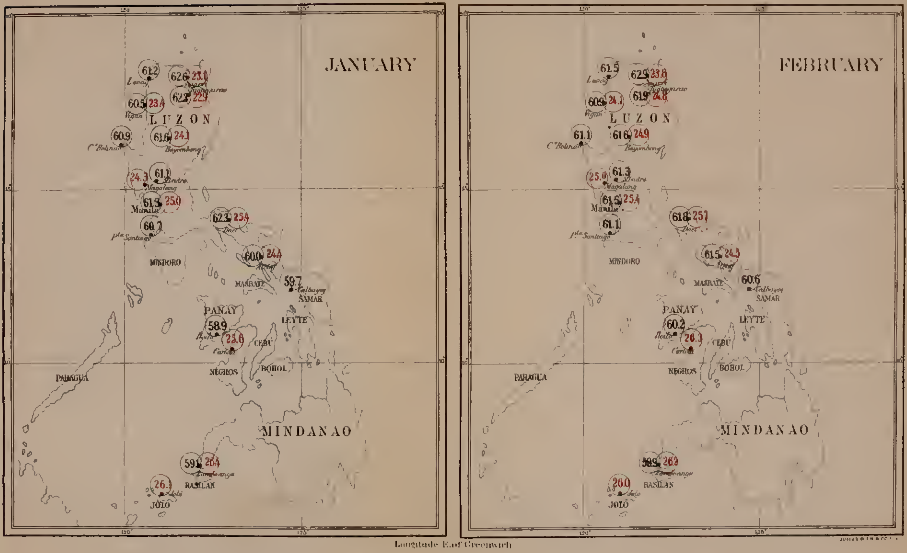
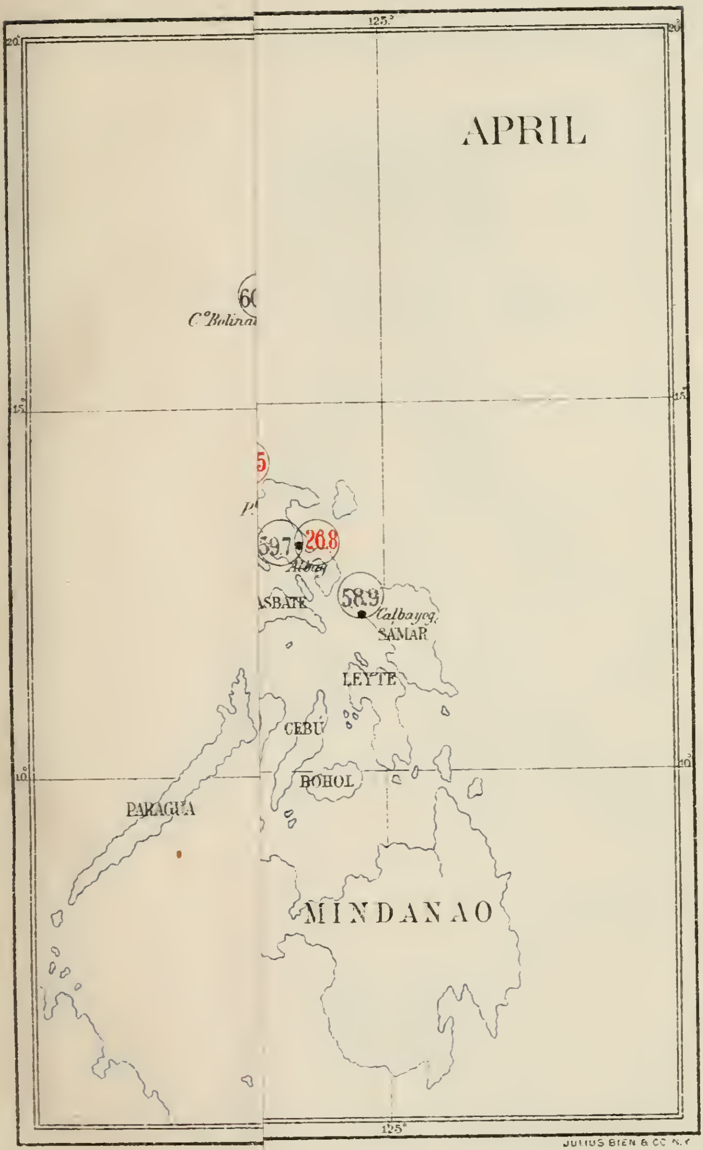
PLATE X



Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

PLATE XI.



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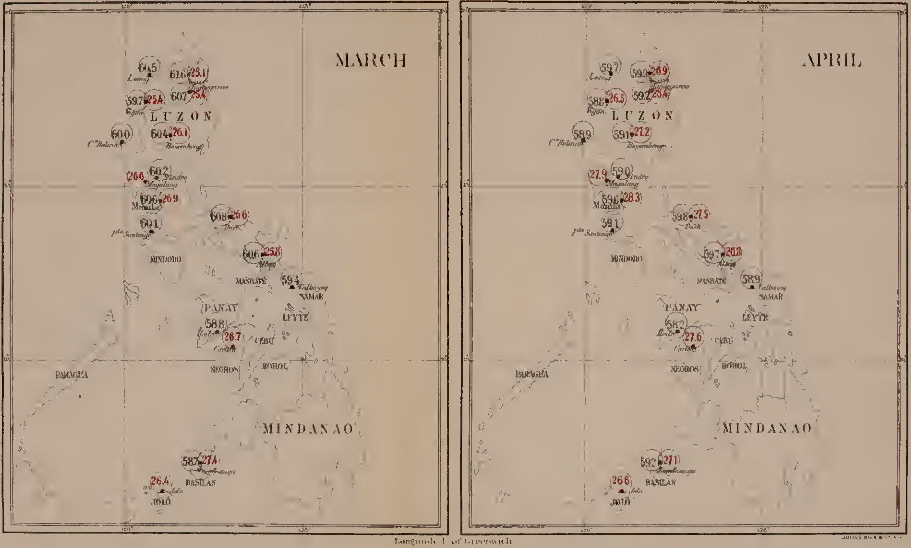
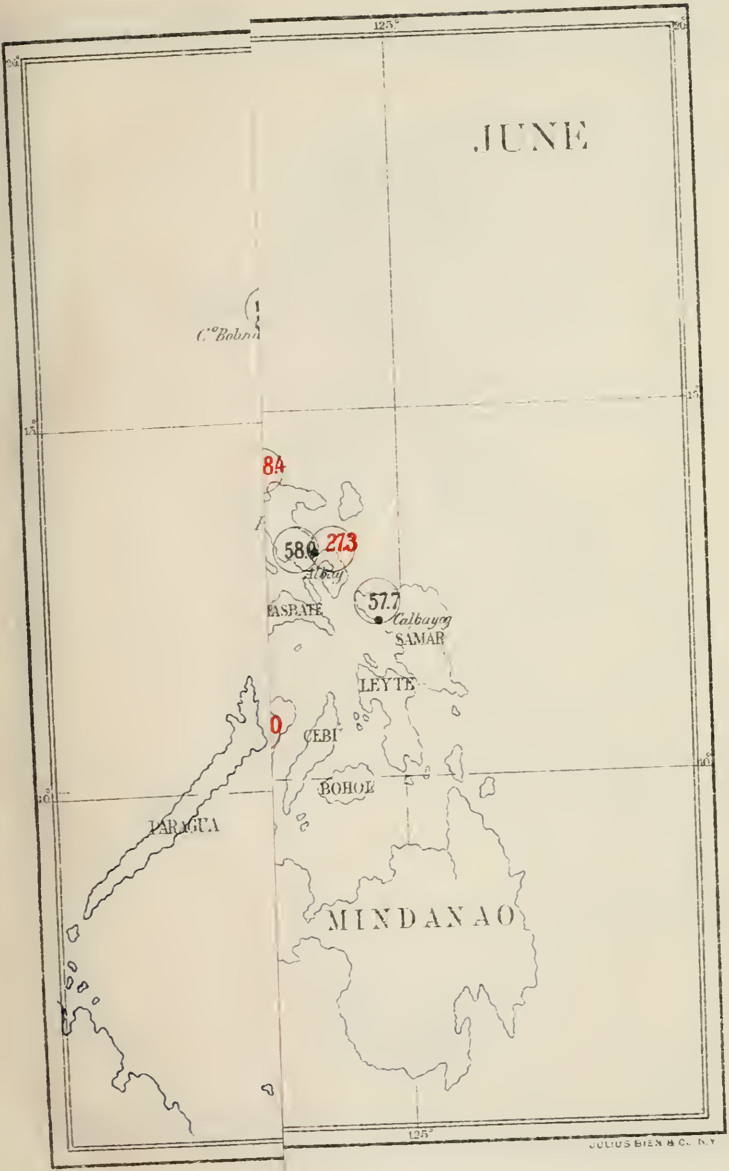
e Archipelago



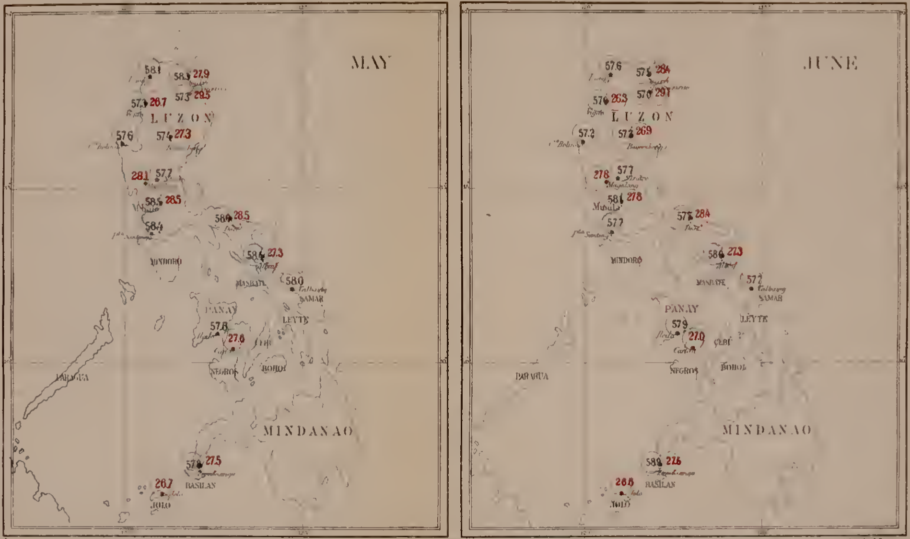
Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

PLATE XII



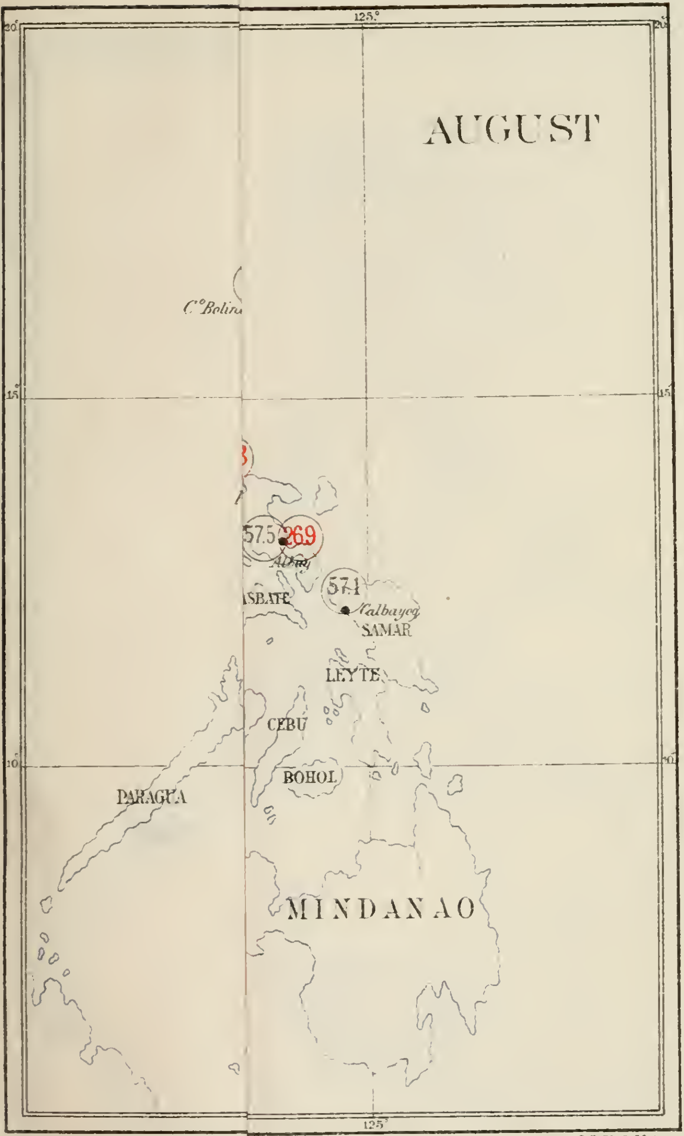
e Archipelago

PLATE XII



Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

PLATE XIII



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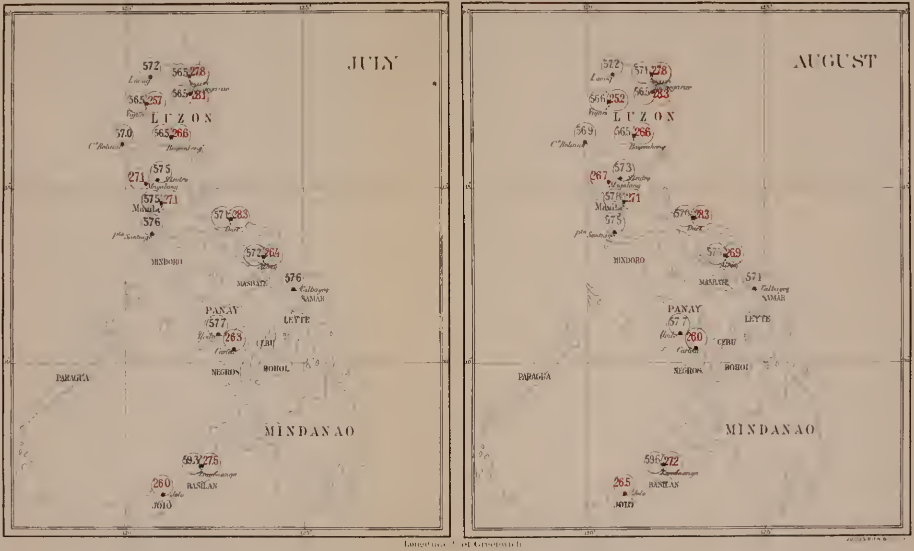
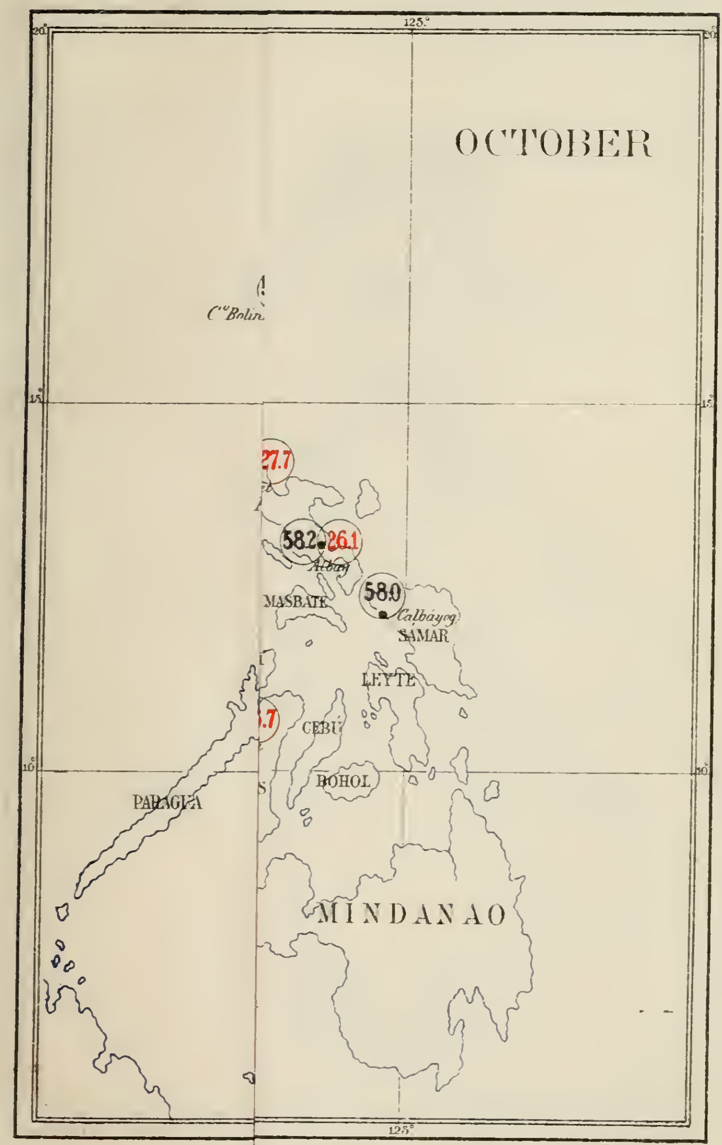


Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

PLATE XIV.



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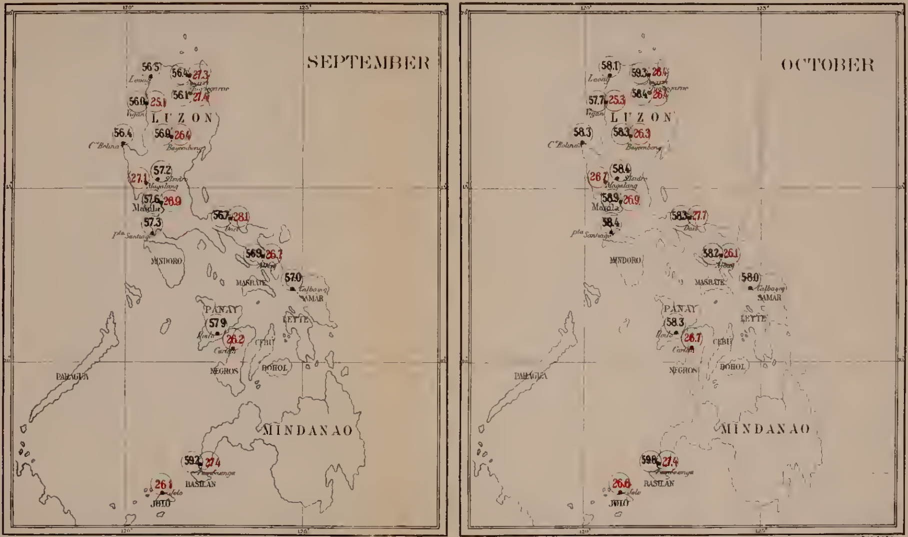
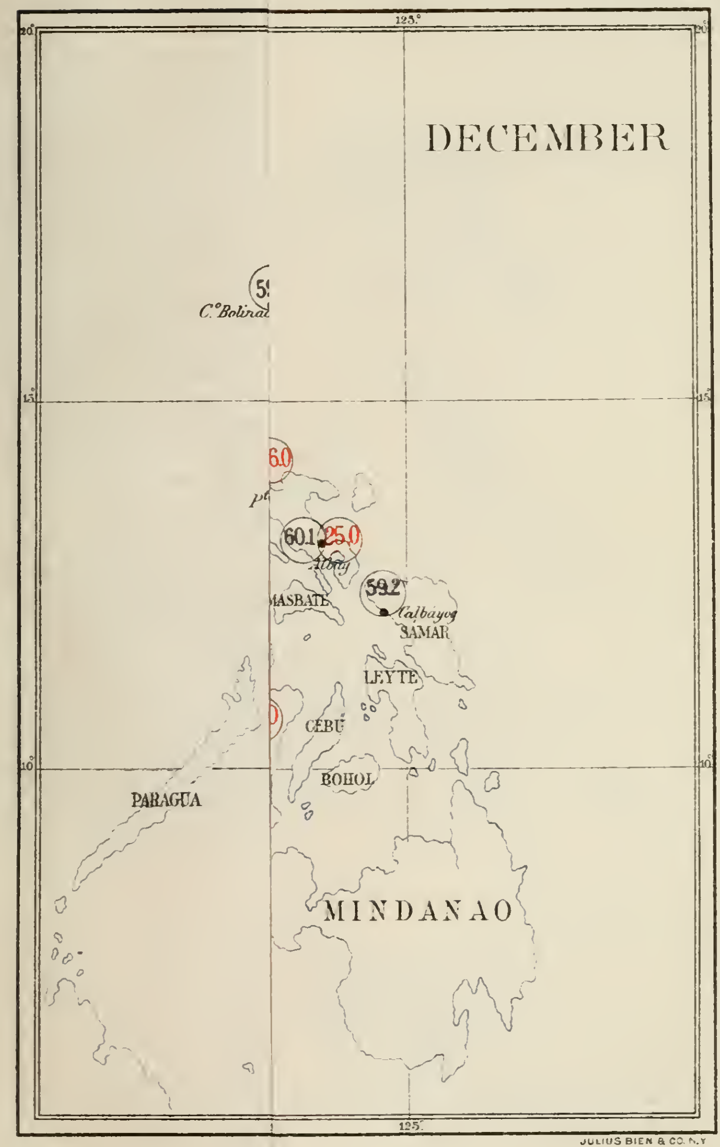


Longitude E. of Greenwich

Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

PLATE XV.



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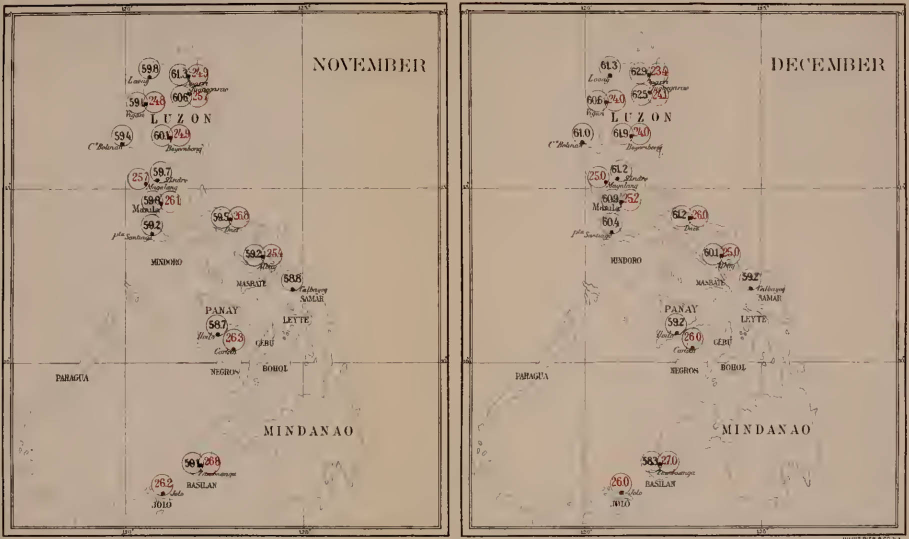


Annual variation of the temperature and of the atmospheric pressure in the Philippine Archipelago

nor the accuracy or exactness with which said observations were made. Notwithstanding, as learned persons were at the head of that farm, whose enthusiasm for meteorological studies we are well aware of, we are led to suppose these data worthy of our confidence and of our attention for a few moments.

The annual variation which the mean monthly values of table XXVII suppose is much less, not only with respect to that of Aparri, but also compared with that of Manila; and, indeed, it ought to be so, as the station of La Carlota is situated much nearer the equator, between 10° and 11° north latitude. The difference between the minimum mean of January and the maximum mean of April and May is only 2°; so that the amplitude of the annual oscillation is less than that of Aparri by 3.3°, and also less than that of Manila by 1.5°. Although the lowest temperature occurs in January and the highest in April and May, the same as in Manila, the minimum mean is greater, and the maximum mean, on the contrary, is less than that of Manila. From May to August the temperature gradually diminishes, again increasing somewhat during September and October, to decrease again from October to January. So that, besides the principal maximum and minimum of May and January, there appears in these monthly means of La Carlota another secondary maximum in October, and there also appears another secondary minimum in the month of August.

In these observations it may be readily seen that the annual variation of the temperature is less in the stations that are nearest the equator. Thus, for example, the amplitude of the annual oscillation is 5.3° in Aparri, 3.5° in Manila, 2.9° in Albay, 2.0° in La Carlota, 1.3° in Zamboanga, and only 0.7° in Jolo.

The lowest temperatures in all the stations belong to January or February, and the highest to May or June.

According to the data of Aparri, we find that the absolute maxima of said station have all been registered in May and June, and the minima in January or February, with the exception of the minimum of 1892, which was observed in the month of December. The absolute maximum of the entire period, 35.7°, corresponds to the month of June, 1886, and the minimum, also for the whole period, 13.1°, which is certainly remarkable, belongs to the month of February, 1888.

CHAPTER IV.

HYGROMETRY.

I.—YEARLY VARIATION IN THE RELATIVE HUMIDITY AT MANILA.

Table XXXIV contains the annual variations of relative humidity at Manila for the period 1883 to 1898. From the monthly averages of this period the curve shown in plate 16 has been drawn.

TABLE XXXIV.—*Monthly and yearly average of relative humidity at Manila during the period 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1883	76.7	73.3	71.6	74.8	77.2	83.0	85.1	83.9	86.6	80.8	78.4	83.8	79.6
1884	77.1	75.7	70.1	68.4	75.1	81.6	86.1	83.8	83.4	79.9	77.4	79.0	78.1
1885	74.2	75.6	68.7	68.3	72.0	75.0	81.0	82.3	80.2	80.8	80.5	78.2	76.4
1886	79.5	74.2	66.8	73.7	75.8	82.5	84.5	82.6	86.7	85.7	81.1	82.9	79.7
1887	81.6	75.6	79.4	78.2	84.1	86.6	90.0	84.8	89.9	83.2	85.3	87.3	83.8
1888	83.6	73.5	71.0	72.0	72.2	82.9	90.8	85.5	82.8	83.7	82.9	80.7	80.1
1889	84.2	80.3	75.9	68.0	68.6	80.0	83.3	84.4	85.8	85.0	83.9	85.8	80.4
1890	78.4	74.2	68.9	73.1	79.2	81.8	83.2	82.4	87.1	85.6	80.5	79.3	79.5
1891	76.0	70.2	70.0	67.0	69.4	84.2	85.8	86.9	86.6	79.4	81.9	79.7	78.1
1892	76.5	72.7	72.3	67.4	75.0	79.0	83.8	84.1	85.9	82.1	82.2	78.4	78.3
1893	76.4	72.8	70.7	71.3	80.1	78.5	84.0	85.2	86.7	82.4	79.0	77.8	78.7
1894	75.0	71.9	70.6	66.9	77.9	81.3	83.0	83.9	85.7	83.0	79.8	80.3	78.3
1895	77.5	73.4	71.1	72.9	83.4	83.4	83.4	34.3	86.8	79.2	80.9	77.1	79.4
1896	73.8	72.7	71.4	66.6	84.1	83.3	84.5	88.8	85.7	83.1	81.9	79.2	79.6
1897	75.6	71.4	69.3	68.2	77.2	76.0	83.5	85.1	85.4	83.1	83.6	83.0	78.5
1898	77.3	77.6	78.9	77.5	79.7	84.1	86.2	83.1	83.6	84.9	85.7	78.7	81.4
Average	77.7	74.1	71.7	70.9	76.9	81.5	84.9	84.4	85.6	82.6	81.6	80.7	79.4

NORMAL AVERAGE VALUES FOR THE DIFFERENT MONTHS OF THE YEAR.

The same humidity is usually noted in April. It increases during May and July, diminishes somewhat in August, again increases in September, when the maximum is reached, and then begins to diminish gradually and without interruption from October until April. From what we have just said, and from what has been said in the two previous chapters, it may be noted that during the month of August an irregularity occurs in the progress of these meteorological elements. When, in Chapter VIII, we shall speak of the monthly distribution of hurricanes, a decrease during that month in their frequency will be noted, although their maximum falls in the month of September. To this, without doubt, may be attributed the decrease during August of the value of the average rainfall and relative humidity, and the slight increase on the other hand of temperature and atmospheric pressure.

THE NORMAL MONTHLY AVERAGE COMPARED WITH THE NORMAL YEARLY AVERAGE.

In the following table the difference between the yearly average, 79.4, and the normal monthly average is shown:

Month.	Monthly average.	Difference.
January	77.7	−1.7
February	74.1	−5.3
March	71.7	−7.7
April	70.9	−8.5
May	76.9	−2.5
June	81.5	+2.1
July	84.9	+5.5
August	84.4	+5.0
September	85.6	+6.2
October	82.6	+3.2
November	81.6	+2.2
December	80.7	+1.3
Average	79.4	

The greatest differences between the yearly average and the monthly averages belong to April and May, the months of least humidity of the year, as are they also of least cloudiness, as will be seen in Chapter VII.

AVERAGE YEARLY EXTREMES—COMPARISON BETWEEN THE AVERAGE NORMAL AND THE AVERAGE EXTREMES OF EACH MONTH.

The average yearly extremes of the period 1883 to 1898 are 83.8 (1887) and 76.4 (1885); a difference of but 7.4. The greatest differences observed between the normal averages of each month and the monthly averages of all the periods may be seen in this table.

Month.	Normal average.	Maximum difference (positive).	Maximum difference (negative).
January	77.7	6.5 (1889)	3.9 (1896)
February	71.1	6.2 (1889)	3.9 (1891)
March	71.7	7.7 (1887)	4.9 (1886)
April	70.9	7.3 (1887)	4.3 (1896)
May	76.9	7.2 (1887 and 1896)	8.3 (1889)
June	81.5	5.1 (1887)	6.5 (1885)
July	84.9	5.9 (1888)	3.9 (1885)
August	84.4	4.4 (1896)	2.1 (1885)
September	85.6	4.3 (1887)	5.4 (1885)
October	82.6	3.1 (1886)	3.4 (1895)
November	81.6	4.1 (1898)	4.2 (1884)
December	80.7	6.6 (1887)	3.6 (1895)

The maximum positive differences are in the months of March, April, and May and the maximum negative differences in May and June.

INCREASED HUMIDITY IN THE PHILIPPINES AND ITS PRINCIPAL CAUSES.

The increased values which, as we have just seen, occur in the yearly average of humidity, as also in the different monthly averages, are convincing proof of the great quantity of watery vapor with which the atmosphere of the Philippine archipelago is generally loaded. This quantity of vapor is due, as is indicated in the official guide to the Philippines in the article on climate, in part to the extraordinary evaporation from the seas which surround it on all sides, and in part to the richness of its vegetation, and in part also to the different prevailing winds of the various seasons of the year and the abundant aqueous precipitation common to tropical countries. The first two may be considered as general causes of humidity which are observed in all the islands. The last two may influence in a greater or less degree the humidity of the various months of the year or the humidity of the different regions of the archipelago. For this reason during those months when the prevailing winds are from the first quadrant and the rains are most abundant on the eastern coasts the humidity will be greater in those towns situated nearest the Pacific, and not in those on the western coasts. These latter, however, will possess greater humidity from June to October, when the prevailing winds are from the third quadrant—that is to say, from west to south. And note in passing that as the rains from June to October are caused principally by atmospheric disturbances, and as these extend their influence more or less over the entire archipelago, it follows that the humidity peculiar to these months must be considerably increased, not alone in the vicinity of the western coast, but also to a certain point in the interior and on the eastern coast. And it being true that from November to March the humidity is greater on the western coast, it is easy to comprehend that the yearly average of humidity must reach its maximum value in those regions most exposed to winds from the first quadrant.

As we have neither time nor sufficient data to carefully study the annual variations of the hygrometric state of the atmosphere in different parts of the archipelago, we have made these few indications, and it will be seen that what is said in the following chapter concerning the yearly distribution of rain in the Philippines will be of great service in this connection.

II.—MONTHLY AND YEARLY MAXIMA AND MINIMA OF RELATIVE HUMIDITY AT MANILA.

The two Tables XXXV and XXXVI contain the yearly and monthly maxima and minima of the relative humidity as observed at Manila during the period 1883 to 1898. Note, however, that these maxima and minima have not been taken with a registering apparatus and can not, therefore, be strictly called absolute. They are simply the maximum and minimum of hourly observations for each month.

TABLE XXXV.—*Yearly and monthly maxima of relative humidity at Manila during the period 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly maxima.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1883...	100.0	99.0	95.0	99.0	99.5	99.5	100.0	100.0	99.5	100.0	99.0	99.0	100.0
1884...	99.5	99.0	93.0	96.0	99.0	99.0	99.0	98.0	98.0	98.0	97.0	97.0	99.5
1885...	99.0	99.5	91.0	97.0	95.0	97.5	100.0	100.0	99.5	100.0	100.0	100.0	100.0
1886...	98.5	97.0	97.0	97.5	100.0	100.0	100.0	100.0	100.0	100.0	99.5	100.0	100.0
1887...	100.0	99.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1888...	100.0	97.5	95.5	99.0	97.	99.5	100.0	100.0	99.5	100.0	100.0	100.0	100.0
1889...	100.0	100.0	98.5	94.0	96.5	99.0	100.0	99.0	100.0	99.5	100.0	100.0	100.0
1890...	100.0	99.5	97.0	100.0	98.5	100.0	100.0	100.0	100.0	100.0	100.0	99.0	100.0
1891...	98.5	97.5	96.0	95.5	99.5	100.0	100.0	100.0	100.0	98.5	100.0	100.0	100.0
1892...	97.0	97.0	99.0	98.0	97.0	98.0	99.0	99.0	100.0	98.0	99.0	98.0	100.0
1893...	99.0	95.0	96.0	94.0	99.0	98.0	99.0	100.0	100.0	99.0	100.0	98.0	100.0
1894...	100.0	97.0	99.0	95.0	99.0	100.0	98.0	99.0	100.0	100.0	100.0	100.0	100.0
1895...	99.0	99.0	96.0	99.0	99.0	100.0	99.0	100.0	100.0	99.0	100.0	99.0	100.0
1896...	98.0	96.0	97.0	94.0	99.0	99.0	99.0	99.0	99.0	98.0	99.0	97.0	99.0
1897...	98.0	95.0	99.0	95.0	98.0	97.0	99.0	100.0	99.0	98.0	98.0	99.0	100.0
1898...	99.0	98.0	98.0	97.0	97.0	99.0	99.0	99.0	100.0	99.0	99.0	98.0	100.0
Average..	99.1	97.8	96.9	96.9	98.3	99.1	99.4	99.6	99.7	99.2	99.1	99.0	99.9

TABLE XXXVI.—*Yearly and monthly minima of relative humidity at Manila during the period of 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly minima.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1883	41.0	40.0	38.5	48.5	45.5	53.0	57.0	58.5	61.0	48.5	45.0	53.0	38.5
1884	44.0	44.5	35.0	39.0	40.5	50.0	58.0	53.0	56.0	49.0	39.0	46.0	35.0
1885	47.0	38.0	34.5	40.0	35.0	42.0	53.5	61.0	51.5	46.0	53.0	39.5	34.5
1886	49.0	41.5	33.5	39.0	43.0	50.0	57.0	56.5	61.5	54.0	46.5	52.0	33.5
1887	48.0	41.0	44.5	51.0	48.5	55.0	60.0	54.5	60.0	50.0	54.0	61.5	41.0
1888	60.5	40.0	36.5	33.0	32.0	55.0	62.5	59.0	51.0	53.0	55.5	47.0	32.0
1889	53.0	52.0	39.5	35.0	37.5	47.5	52.5	57.0	55.0	57.0	56.0	54.0	35.0
1890	41.0	43.5	35.0	45.5	47.0	49.0	56.0	57.0	60.0	48.0	47.5	51.0	35.0
1891	42.5	42.5	37.0	36.0	37.5	55.5	62.5	59.0	58.5	47.5	46.0	50.0	36.0
1892	46.0	37.0	36.0	39.0	42.0	36.0	58.0	54.0	60.0	55.0	52.0	45.0	36.0
1893	41.0	40.5	40.0	39.0	44.0	50.0	53.5	58.0	61.0	48.0	51.0	52.0	39.0
1894	43.0	33.0	38.0	38.0	45.0	51.0	56.0	54.0	59.0	59.0	51.0	48.0	33.0
1895	45.0	41.0	39.0	42.0	52.0	49.0	55.0	52.0	58.0	50.0	45.0	48.0	39.0
1896	42.0	42.0	40.0	33.0	52.0	54.0	57.0	61.0	62.0	57.0	58.0	53.0	33.0
1897	40.0	42.0	31.5	35.5	39.0	42.0	58.0	56.0	59.0	52.0	57.0	56.0	31.5
1898	46.5	48.0	49.0	50.0	50.0	57.0	61.0	59.0	52.0	58.0	59.0	51.5	46.5
Average	45.6	41.7	38.0	40.2	43.2	49.8	57.3	56.8	57.8	52.0	51.0	50.0	36.2

MAXIMA OF RELATIVE HUMIDITY.

We have but little to say concerning the monthly maxima. As will be seen in Table XXXV, this frequently reached a value of 98, 99, and 100 (state of saturation) even in the months which are noted for least humidity, such as February, March, and April. This is not strange, as a month seldom passes without several rainy days—at least for a few hours—and in these cases the condensation of the vapor and the aqueous precipitation naturally increase the hygrometric condition of the air, this being the cause of the uniform maximum relative humidity of all the months of the year, which always exceeds 90.

GRADATION BETWEEN THE MONTHLY AVERAGES AND THE MAXIMA.

Nevertheless, examining the average values of the maxima of each month, we find a complete gradation, which may be attributed to the constancy or greater frequency with which the air becomes completely saturated with watery vapor in the months of greatest average humidity.

Thus the smallest averages are for April, March, and February; then come May, December, January, June, October, November, and July, the largest being in August and September.

AVERAGES OF MONTHLY MINIMA.

The averages of monthly minima oscillate between 38, the average for March, and 57.8, the average for September. After the average of March follow, in ascending order, those of April, February, May, January, June, December, November, October, August, July, and September, a gradation, as will be seen, very different from that observed between the averages of the maxima.

MONTHLY MINIMA OF ALL THE PERIOD.

The monthly minima for the entire period is shown in the following table:

January	40	(1897)	July	52.5	(1889)
February	33	(1894)	August	52	(1895)
March	31.5	(1897)	September	51	(1888)
April	33	(1888 and 1896)	October	46	(1885)
May	32	(1888)	November	39	(1884)
June	36	(1892)	December	39.5	(1885)

YEARLY MINIMA.

The minimum for the entire period is 31.5, observed on the 13th of March, 1897. The greatest annual minimum was 46.5, in 1898, differing from the average by 15. The years 1887 and 1898 are the only ones which show a yearly minimum greater than 40.

MONTHLY FREQUENCY OF THE YEARLY MINIMA.

The yearly minima of all the period are distributed in the different months of the year as follows:

January	1	April	4
February	2	May	1
March	8	June	1

III.—MONTHLY AVERAGES OF THE DAILY MAXIMA AND MINIMA OF THE RELATIVE HUMIDITY AT MANILA—AVERAGE VALUES OF THE DAILY VARIATION.

Tables XXXVII and XXXVIII include the monthly averages deduced from the absolute daily maxima and minima of relative humidity during the period 1885 to 1898. The difference between these two tables, or what is the same thing, the difference between the average maxima and minima of each month, gives us the average monthly variation of relative humidity which is included in Table XXXIX.

TABLE XXXVII.—*Monthly averages of daily maxima of relative humidity of Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Averages.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1885	89.2	89.6	84.6	83.6	86.5	91.0	94.4	95.8	94.7	94.9	94.1	91.0	90.8
1886	92.3	88.6	83.2	88.0	90.4	95.8	98.2	97.4	98.1	97.1	94.8	95.3	93.3
1887	96.2	92.3	94.3	94.1	98.1	98.6	98.1	97.8	98.6	96.3	97.0	98.3	96.6
1888	95.6	91.6	89.4	91.2	91.3	96.3	98.1	96.3	96.4	96.4	96.7	95.1	94.5
1889	98.0	95.4	92.1	86.9	87.2	95.0	96.7	96.2	97.7	96.3	95.4	95.8	94.4
1890	94.1	93.3	88.8	90.4	94.9	95.3	96.0	97.1	97.3	97.5	93.8	95.0	94.5
1891	90.7	87.1	86.9	84.6	86.5	95.9	95.9	96.8	97.0	94.6	94.5	93.2	92.0
1892	91.1	89.6	90.4	86.2	91.6	94.6	95.2	96.7	95.6	94.5	93.9	91.4	92.6
1893	91.5	89.7	87.7	87.5	94.1	93.2	95.0	96.7	96.8	94.8	91.4	90.4	92.4
1894	90.6	87.9	87.2	85.7	92.8	95.0	95.6	95.9	96.7	96.0	93.9	96.4	92.8
1895	92.4	90.5	88.1	89.1	95.2	95.9	95.9	95.9	96.5	94.3	95.0	91.2	93.3
1896	89.7	89.1	87.8	83.7	94.8	95.5	95.5	96.5	95.8	94.7	94.9	93.0	92.6
1897	90.9	87.2	86.1	84.7	91.2	90.3	95.0	95.5	95.7	94.9	95.3	94.0	91.7
1898	91.2	92.8	92.9	92.5	93.6	95.4	96.1	93.0	95.6	95.0	95.4	91.4	93.7
Average	92.4	90.3	88.5	87.7	92.0	94.8	96.1	96.3	96.6	95.5	94.7	93.7	93.2

TABLE XXXVIII.—*Monthly averages of the daily minima of relative humidity at Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1885	57.2	57.6	51.2	50.2	52.8	56.8	67.5	67.8	64.2	63.8	65.2	66.2	60.0
1886	63.6	57.3	48.3	54.7	58.9	65.7	67.8	65.0	71.9	68.2	63.8	67.3	62.7
1887	63.8	58.4	61.2	61.3	66.4	69.6	78.4	66.6	76.5	66.8	69.5	71.4	67.5
1888	69.4	52.9	50.9	50.8	50.2	67.9	79.1	72.5	65.0	66.3	65.6	62.4	62.8
1889	66.8	63.1	54.0	46.5	48.3	60.2	67.1	68.6	67.1	68.7	69.2	72.1	62.6
1890	58.4	55.0	46.9	54.4	60.7	64.2	67.6	65.2	72.4	69.5	64.1	61.0	61.6
1891	59.7	52.3	50.0	47.6	49.7	69.4	73.7	74.1	74.5	61.1	64.8	64.8	61.8
1892	60.3	51.8	51.2	47.6	53.4	59.1	69.1	65.9	72.8	65.9	67.4	61.8	60.5
1893	58.2	53.1	51.0	51.1	62.5	59.7	68.7	70.6	72.5	66.9	65.0	62.9	61.9
1894	56.6	53.1	52.4	47.3	58.9	64.6	66 9	69.1	70.7	66.4	63.6	64.4	61.2
1895	58.2	53.4	51.7	54.4	68.4	67.0	67.0	69.1	74.1	61.2	63.9	60.6	62.4
1896	54.7	53.6	51.7	47.9	69.0	68.3	69.1	77.5	72.7	69.0	66.2	63.7	63.6
1897	55.4	54.0	49.6	48.4	59.2	59.7	68.1	70.2	71.8	67.2	68.1	69.2	61.7
1898	61.2	60.6	62.9	60.0	63.5	70.2	70.7	72.8	65.7	70.0	72.8	64.3	66.2
Average	60.3	55.4	52.4	51.6	58.7	64.5	70.1	69.6	70.9	66.5	66.4	65.2	62.6

PLATE XVII.

DAILY VARIATION OF THE RELATIVE HUMIDITY AT MANILA

1890-1898

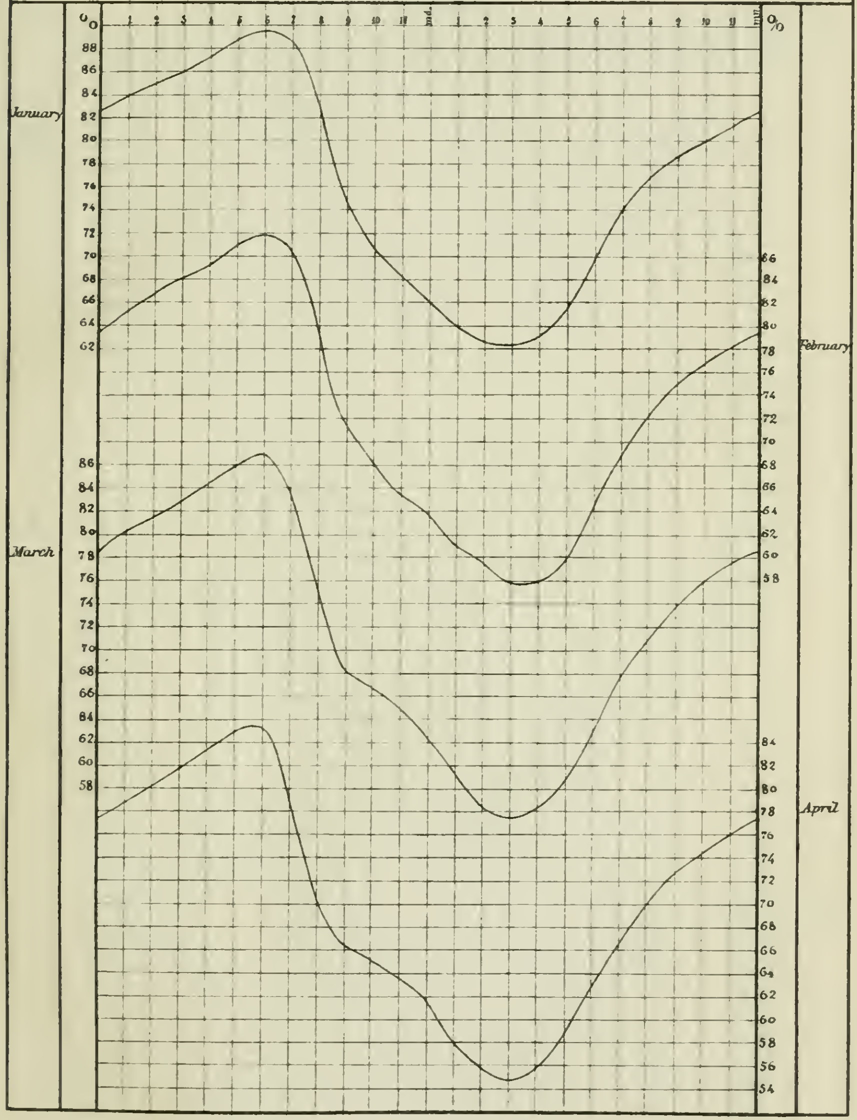


PLATE XVIII.

DAILY VARIATION OF THE RELATIVE HUMIDITY AT MANILA

1890-1898

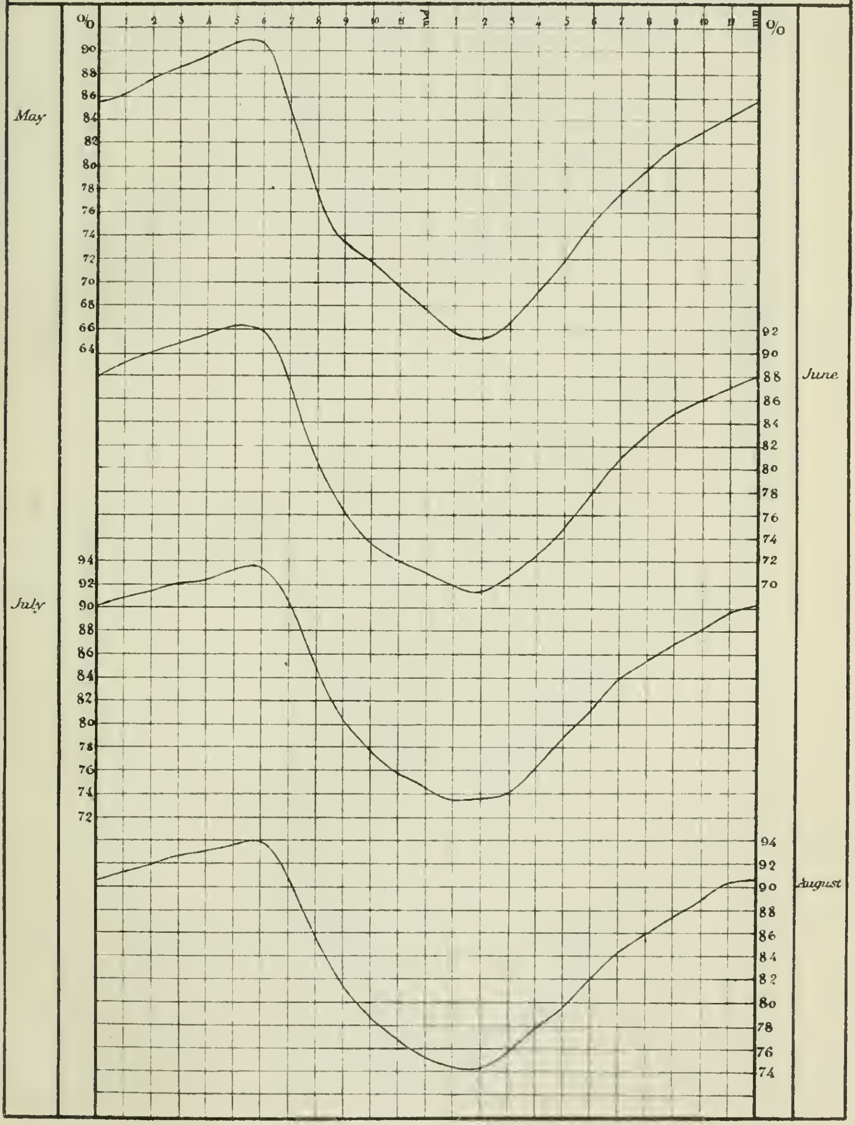
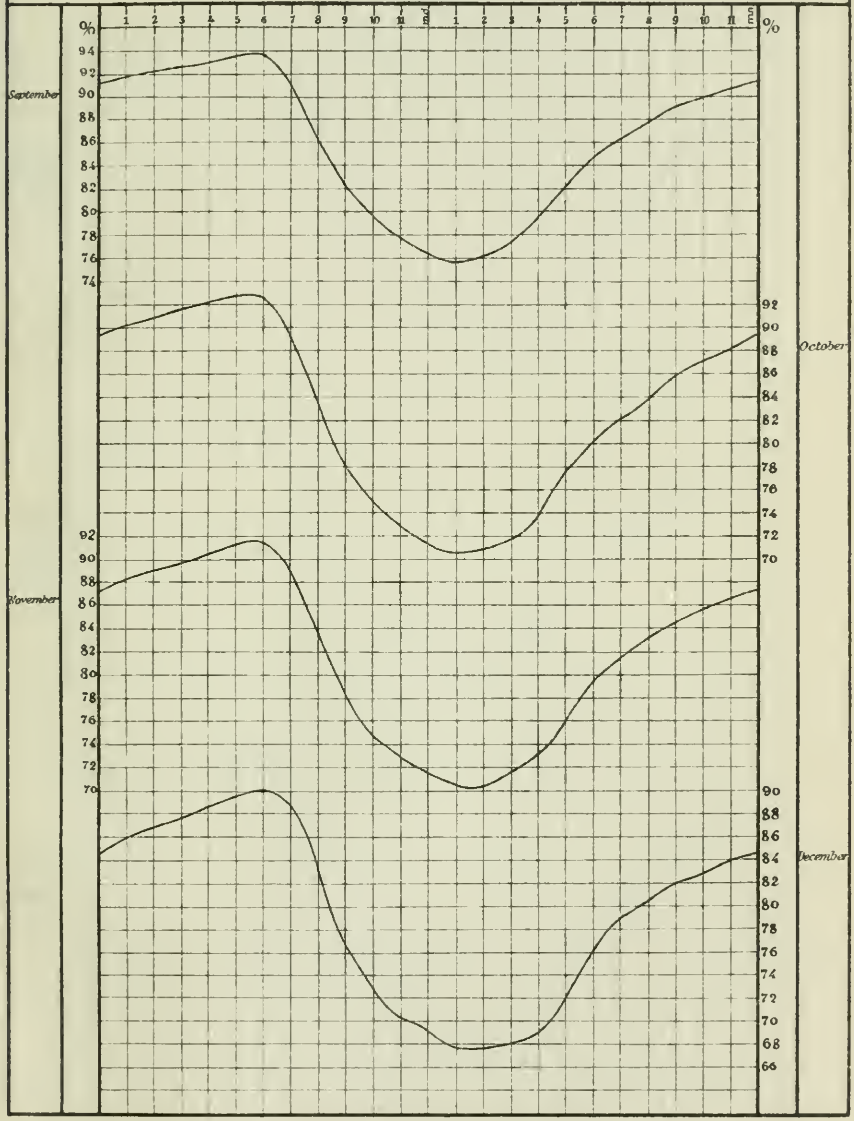


Plate XIX.

DAILY VARIATION OF THE RELATIVE HUMIDITY AT MANILA

1890-1898



DAILY VARIATION OF THE RELATIVE HUMIDITY AT MANILA

1890-1898

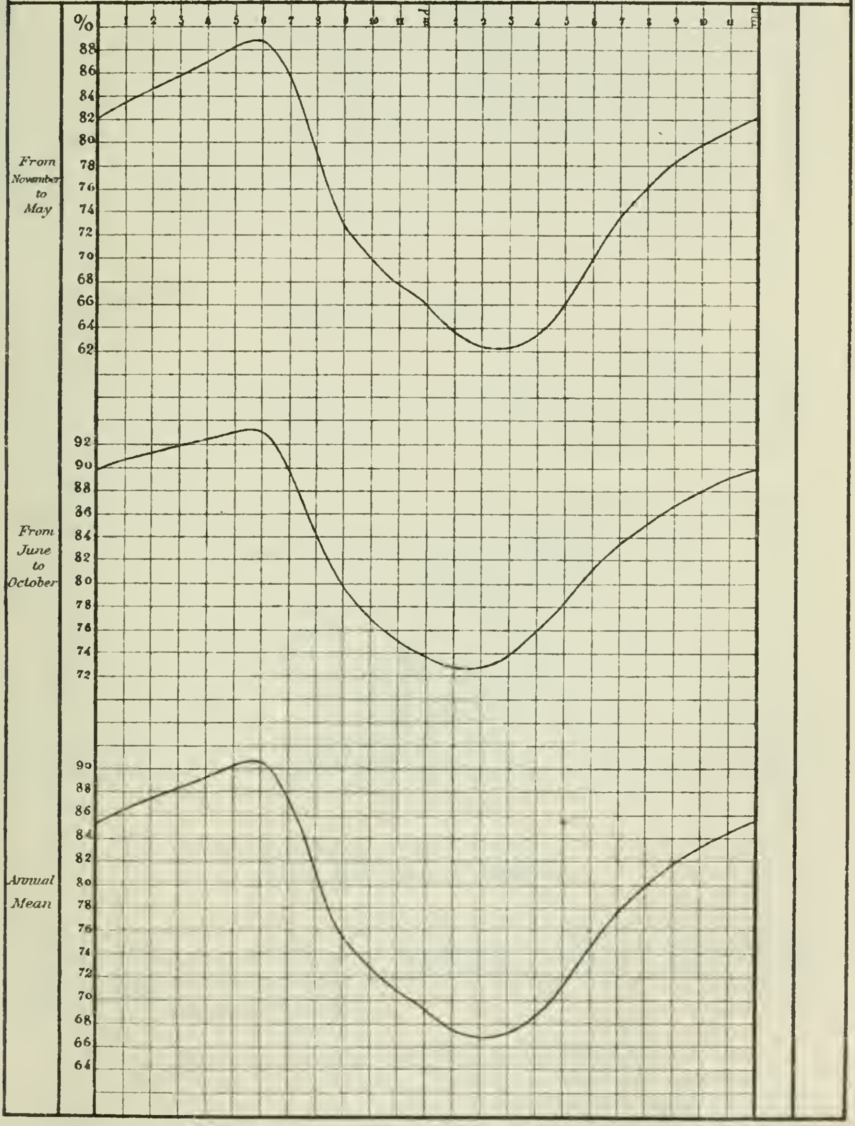


TABLE XXXIX.—*Average monthly variation of the relative humidity at Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1885	32.0	32.0	33.4	33.4	33.7	34.2	26.9	28.0	30.5	31.1	28.9	24.8	30.7
1886	28.7	31.3	34.9	33.3	31.5	30.1	30.4	32.4	26.2	28.9	31.0	28.0	30.6
1887	32.4	33.9	33.1	32.8	31.7	29.0	19.7	31.2	22.1	29.5	27.5	26.9	29.2
1888	26.2	38.7	38.5	40.4	41.1	28.4	19.0	23.8	31.4	30.1	31.1	32.7	31.8
1889	31.2	32.3	38.1	40.4	38.9	34.8	29.6	27.6	30.6	27.6	26.2	23.7	31.8
1890	35.7	38.3	41.9	36.0	34.2	31.1	28.4	31.9	24.9	28.0	29.7	34.0	32.8
1891	31.0	34.8	36.9	37.0	36.8	26.5	22.2	22.7	22.5	33.5	29.7	28.4	30.2
1892	30.8	37.8	39.2	38.6	38.2	35.5	26.1	30.8	22.8	28.6	26.5	29.6	32.0
1893	33.3	36.6	36.7	36.4	31.6	33.5	26.3	26.1	24.3	27.9	26.4	27.5	30.6
1891	34.0	34.8	34.8	38.4	33.9	30.4	28.7	26.8	26.0	29.6	30.3	32.0	31.6
1895	34.2	37.1	36.4	34.7	26.8	28.9	28.9	26.8	22.4	33.1	31.1	30.6	30.9
1896	35.0	35.5	36.1	35.8	25.8	27.2	26.4	19.0	23.1	25.7	28.7	29.3	29.0
1897	35.5	33.2	36.5	36.3	32.0	30.6	26.9	25.3	23.9	27.7	27.2	24.8	30.0
1898	30.0	32.2	30.0	32.5	30.1	25.2	25.4	20.2	29.9	25.0	22.6	27.1	27.5
Average	32.1	34.9	36.1	36.1	33.3	30.4	26.1	26.6	25.8	29.0	28.1	28.5	30.6

RELATION BETWEEN THE AVERAGE MONTHLY MAXIMA AND MINIMA OF RELATIVE HUMIDITY.

The relation which is noted between the different monthly averages at the end of Tables XXXVII and XXXVIII is in both almost the same and very similar to that shown in Table XXXIV of paragraph 1 of this chapter, which considered the yearly variation of relative humidity at Manila.

Considering each one of the fourteen years included in these tables separately, we see that the greatest average of daily maxima was 98.6, corresponding to the months of June and September, 1887. In the months of February, March, and April, especially in the latter two, the average maxima less than 90 prevailed. From June to December, inclusive, all are greater than 90, and in January and May, although there are some less than 90, the majority exceed this figure. The smallest average of daily minima during this entire period of fourteen years was 46.5, corresponding to the month of April, 1889. The averages of minima for the months July to December are, without exception, above 60, and generally above 50 for the other months of the year. In June the most of the averages are above 60.

THE AVERAGE OF DAILY MAXIMA AND MINIMA FOR ALL THE PERIOD. AVERAGE YEARLY EXTREMES.

The average of all the daily maxima from the period 1885 to 1898 is 93.2 and of the minima 62.6—a difference of 30.6. The greatest yearly average of the maxima is 96.6 (1887) and the smallest yearly average of the minima 60 (1885).

AVERAGE MONTHLY VARIATION OF HUMIDITY.

As will be seen in the average values given us by Table XXXIX, the greatest variation in humidity takes place in March and April, then follow February, May, January, June, October, December, and November. The months of slightest variation are August, July, and September. The difference between the normal variation of March and April, 36.1, and that of September, which is the least, 25.8, is

10.3. The average variation for the entire period is 30.6. In the following paragraph we shall speak more fully of this gradation of variations of humidity belonging to the different months of the year.

AVERAGE EXTREME VARIATIONS OF THE ENTIRE PERIOD.

The average maximum variation for all the entire period was in the month of March, 1890, when it reached the value of 41.9. The minimum, 19, was during the months of July, 1888, and August, 1896.

AVERAGE ANNUAL VARIATION.

The average variations deduced for each one of the fourteen years of the period vary between 32.8 (1890) and 22.5 (1898).

IV.—DAILY VARIATION OF RELATIVE HUMIDITY IN MANILA.

Table XL contains the hourly, monthly, annual, and semiannual averages deduced for the period 1890 to 1898. From these average values the curves of Plates XVII, XVIII, and XIX have been drawn.

TABLE XL.—*Hourly, monthly, annual, and semiannual averages of relative humidity deduced for the period 1890 to 1898.*

FORENOON.

Month.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
January	83.9	85.0	86.0	87.3	88.8	89.5	88.5	82.8	74.7	70.7	68.3	66.1
February	81.2	82.7	84.1	85.2	86.9	87.8	86.4	79.2	71.4	68.1	65.4	63.7
March	80.2	81.4	82.8	84.3	85.9	86.9	83.4	75.1	68.2	66.7	64.9	62.3
April	78.8	80.2	81.7	83.3	84.9	85.2	79.3	70.4	66.5	65.2	63.5	61.5
May	86.3	87.6	88.6	89.6	90.7	90.7	84.9	77.7	73.4	71.7	69.5	67.5
June	89.2	90.1	90.9	91.6	92.3	91.9	87.2	80.5	76.1	73.4	71.9	70.9
July	91.0	91.5	92.1	92.5	93.3	93.4	90.3	84.8	80.3	77.6	75.7	74.5
August	91.3	91.9	92.7	93.1	93.6	93.9	90.8	85.6	81.4	78.7	76.8	75.2
September	91.8	92.3	92.7	93.0	93.6	93.7	91.1	86.3	82.4	79.6	77.8	76.5
October	90.3	90.9	91.7	92.2	92.8	92.7	89.5	83.8	78.1	75.0	72.9	71.3
November	88.3	89.1	89.7	90.5	91.3	91.5	89.0	83.6	78.4	74.7	72.9	71.5
December	86.0	86.9	87.6	88.7	89.5	90.1	88.7	83.3	76.7	72.8	70.3	69.2
Average	86.53	87.47	88.38	89.28	90.30	90.61	87.43	81.09	75.63	72.95	70.83	69.18
Average, November to May	83.53	84.70	85.79	86.99	88.29	88.81	85.74	78.87	72.76	69.99	67.83	65.97
Average, June to October.	90.72	91.34	92.02	92.48	93.12	93.12	89.78	84.20	79.66	76.36	75.02	73.68

AFTERNOON.

Month.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Average.
January	64.0	62.6	62.4	63.1	65.4	69.6	74.0	76.7	78.6	80.0	81.3	82.6	76.3
February	61.0	59.5	57.8	57.9	59.7	64.3	68.7	72.2	74.9	76.7	78.2	79.4	73.0
March	59.3	56.3	55.4	56.3	58.8	62.9	67.7	70.9	73.7	75.9	77.5	78.5	71.5
April	57.8	55.6	54.6	55.7	58.7	62.8	66.6	70.0	72.6	74.3	76.0	77.3	70.1
May	65.6	65.2	66.6	69.3	71.9	75.1	77.6	79.8	81.7	83.0	84.3	85.6	78.5
June	69.8	69.4	70.7	72.6	74.9	78.0	80.9	83.0	84.8	86.0	87.0	88.0	81.3
July	73.5	73.6	74.1	76.3	79.0	81.2	83.9	85.4	86.9	88.2	89.6	90.2	81.1
August	71.4	74.3	75.6	77.8	79.5	82.0	84.3	85.9	87.4	88.8	90.3	90.6	81.8
September	75.7	76.2	77.4	79.5	82.1	84.7	86.3	87.7	89.1	89.9	90.7	91.3	85.9
October	70.6	70.9	71.7	73.8	76.6	80.2	82.1	83.8	85.9	87.1	88.2	89.4	82.6
November	70.5	70.4	71.6	73.1	76.1	79.4	31.5	83.2	84.5	85.6	86.6	87.3	81.7
December	67.7	67.6	68.1	69.0	72.0	76.1	78.9	80.4	82.0	82.8	84.0	84.6	79.3
Average	67.49	66.80	67.17	68.70	71.23	74.69	77.71	79.92	81.84	83.19	84.48	85.40	79.09
Average, November to May	63.70	62.46	62.36	63.49	66.09	70.03	73.57	76.17	78.29	79.76	81.13	82.19	75.77
Average, June to October	72.80	72.88	73.90	76.00	78.42	81.22	83.50	85.16	86.82	88.00	89.16	89.90	83.74

During all the months of the year the daily course of relative humidity contains a single variation exactly opposite to the temperature variation described in paragraph 5 of the previous chapter. The maximum and minimum of this variation is observed between 5 and 6 in the morning and between 1 and 3 in the afternoon, respectively, the hours of greatest humidity coinciding with those of lowest temperature and those of least humidity with the hours of highest temperature.

LAWS OF THIS VARIATION IN THE DIFFERENT MONTHS OF THE YEAR.

The laws governing this daily variation in the relative humidity are easily deduced from the following table, made in the same way as those which, in their corresponding place, serve for the study of the laws of the daily course of atmospheric pressure and of the temperature of the air:

Month.	Hours of—		Amplitude of variation.
	Maximum.	Minimum.	
January	6 a.m.	3 p.m.	27.1
February	6 a.m.	3 p.m.	30.0
March	6 a.m.	3 p.m.	31.5
April	6 a.m.	3 p.m.	30.6
May	5 a.m. 6 a.m.	2 p.m.	25.5
June	5 a.m.	2 p.m.	22.9
July	6 a.m.	1 p.m.	19.9
August	6 a.m.	2 p.m.	19.6
September	6 a.m.	1 p.m.	18.0
October	5 a.m.	1 p.m.	22.2
November	6 a.m.	2 p.m.	21.1
December	6 a.m.	2 p.m.	22.5
Average			24.2

From this data the conclusions may be drawn, first, that those months in which the variation in humidity is greatest are the four months showing greatest thermic variation; that is to say, March, April, February, and January (in descending scale); second, that the minimum variation in humidity is observed in those months showing the minimum thermic variation; that is to say, July, August, and September; third, that the average amplitude of variation oscillates between 27.1 and 31.5 during the months from January to April, between 19.9 and 18.0 during the months from July to September, and between 25.5 and 21.1 during the rest of the months of the year; fourth, that with very slight differences the average maxima and minima of the different months of the year correspond to the same hours of the average maxima and minima of temperature. It follows, therefore, that the hour of maximum humidity is advanced or retarded simultaneously with that of minimum temperature, and so the hour of minimum humidity is advanced or retarded with that of maximum temperature.

ANNUAL AND SEMIANNUAL AVERAGE OF DAILY VARIATION.

With the annual and semiannual averages of Table XL, we have formed the accompanying table, which represents the average annual and semiannual variation in relative humidity. In this it will be noticed that the hour of annual and semiannual maxima and minima are the same as those given in paragraph 5 of the preceding chapter for the annual and semiannual minima and maxima of temperature:

	Hours of—		Amplitude of variation.
	Maxima.	Minima.	
Annual	6 a.m.	2 p.m.	23.81
November to May	6 a.m.	3 p.m.	26.45
June to October	5 a.m. 6 a.m.	1 p.m.	20.32

THE OBJECT OF TABLE XLI AND CONCLUSIONS WHICH MAY BE DRAWN FROM IT.

All that we have just suggested in the preceding lines is fully confirmed in the first part of Table XLI, in which we include in the first place the differences between the hourly averages of Table XL and the respective monthly average, adding, then, under each one of these differences the average increase or decrease experienced in the relative humidity of each one of the twenty-four hours compared with that immediately preceding it. From this second part of the table we can deduce conclusions and considerations analogous to those found in paragraph 6 of the preceding chapter, referring to the daily variation of temperature. So, in order to avoid useless repetitions, it is sufficient to say that, in general, considering both the annual result and those of the different months of the year, it can be said that the hours of greatest increase in relative humidity are those of greatest decrease of temperature, and on the other hand, the hours in which humidity decreases with greatest rapidity are the same ones in which temperature most notably increases.

TABLE XLI.—*Differences between the hourly averages compared with each other and between the same hourly averages and the monthly averages of relative humidity in Manila.*

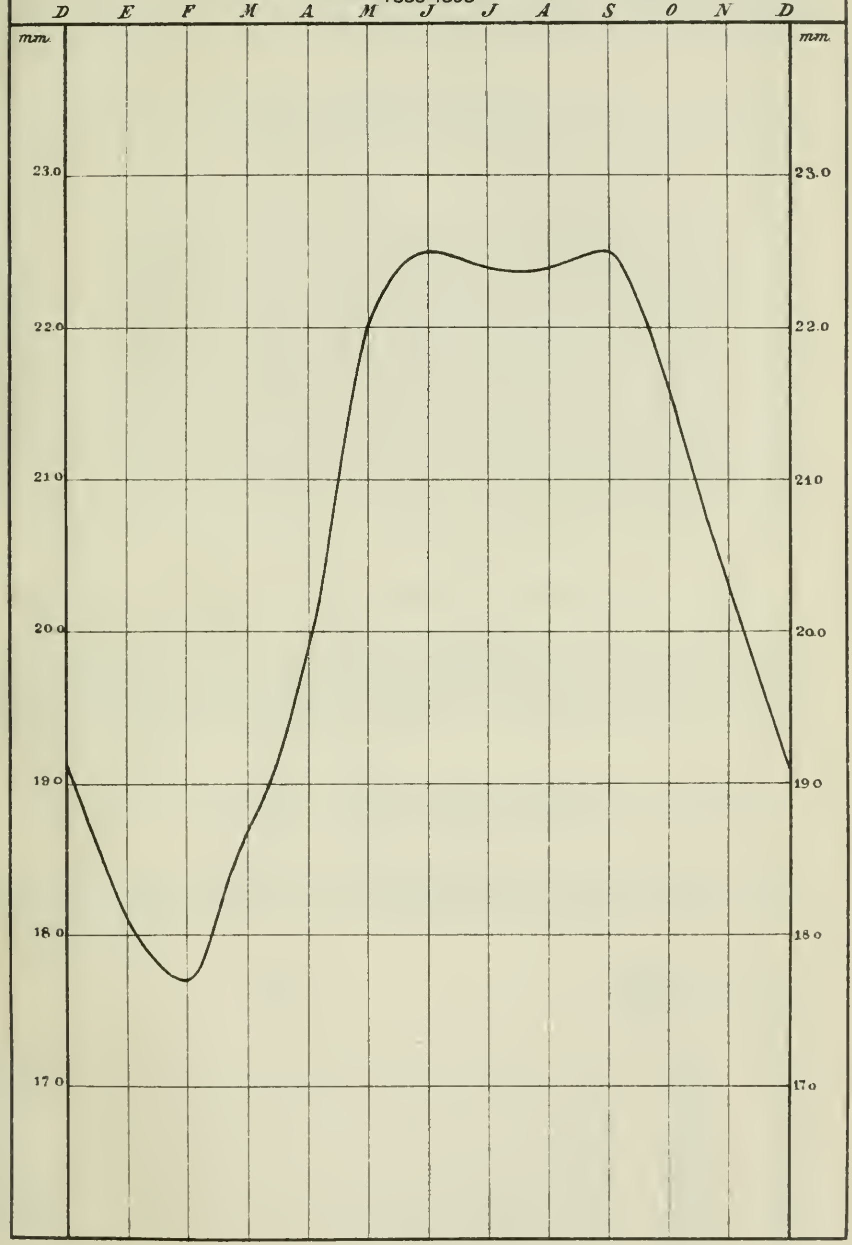
Hour.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1 a. m	**7.6**	**8.2**	**8.7**	**8.7**	**7.8**	**7.9**	**6.9**	**6.5**	**5.9**	**7.7**	**6.6**	**6.7**	**7.44**
0-1 a. m	1.3	1.8	1.7	1.5	0.7	1.2	0.8	0.7	0.5	0.9	1.0	1.1	1.13
2 a. m	**8.7**	**9.7**	**9.9**	**10.1**	**9.1**	**8.8**	**7.4**	**7.1**	**6.4**	**8.3**	**7.4**	**7.6**	**8.38**
1-2 a. m	1.1	1.5	1.2	1.4	1.3	0.9	0.5	0.6	0.5	0.6	0.8	0.9	0.94
3 a. m	**9.7**	**11.1**	**11.3**	**11.6**	**10.1**	**9.6**	**8.0**	**7.9**	**6.8**	**9.1**	**8.0**	**8.3**	**9.29**
2-3 a. m	1.0	1.1	1.4	1.5	1.0	0.8	0.6	0.8	0.4	0.8	0.6	0.7	0.91
4 a. m	**11.0**	**12.2**	**12.8**	**13.2**	**11.1**	**10.3**	**8.4**	**8.3**	**7.1**	**9.6**	**8.8**	**9.4**	**10.19**
3-4 a. m	1.3	1.1	1.5	1.6	1.0	0.7	0.4	0.4	0.3	0.5	0.8	1.1	0.90
5 a. m	**12.5**	**13.9**	**14.4**	**14.8**	**12.2**	**11.0**	**9.2**	**8.8**	**7.7**	**10.2**	**9.6**	**10.2**	**11.21**
4-5 a. m	1.5	1.7	1.6	1.6	1.1	0.7	0.8	0.5	0.6	0.6	0.8	0.8	1.02
6 a. m	**13.2**	**14.8**	**15.4**	**15.1**	**12.2**	**10.6**	**9.3**	**9.1**	**7.8**	**10.1**	**9.8**	**10.8**	**11.52**
5-6 a. m	0.7	0.9	1.0	0.3	0.0	− 0.4	0.1	0.3	0.1	− 0.1	0.2	0.6	0.31
7 a. m	**12.2**	**13.4**	**11.9**	**9.2**	**6.4**	**5.9**	**6.2**	**6.0**	**5.2**	**6.9**	**7.3**	**9.4**	**8.34**
6-7 a. m	− 1.0	− 1.4	− 3.5	− 5.9	− 5.8	− 4.7	− 3.1	− 3.1	− 2.6	− 3.2	− 2.5	− 1.4	− 3.18
8 a. m	**6.5**	**6.2**	**3.6**	**0.3**	**− 0.8**	**− 0.8**	**0.7**	**0.8**	**0.4**	**1.2**	**1.9**	**4.0**	**2.00**
7-8 a. m	− 5.7	− 7.2	− 8.3	− 8.9	− 7.2	− 6.7	− 5.5	− 5.2	− 4.8	− 5.7	− 5.4	− 5.4	− 6.31
9 a. m	**− 1.6**	**− 1.6**	**− 3.3**	**− 3.6**	**− 5.1**	**− 5.2**	**− 3.8**	**− 3.4**	**− 3.5**	**− 4.5**	**− 3.3**	**− 2.6**	**− 3.46**
8-9 a. m	− 8.1	− 7.8	− 6.9	− 3.9	− 1.3	− 1.4	− 4.5	− 4.2	− 3.9	− 5.7	− 5.2	− 6.6	− 5.46
10 a. m	**− 5.6**	**− 4.9**	**− 4.8**	**− 4.9**	**− 6.8**	**− 7.9**	**− 6.5**	**− 6.1**	**− 6.3**	**− 7.6**	**− 7.0**	**− 6.5**	**− 6.24**
9-10 a. m	− 1.0	− 3.3	− 1.5	− 1.3	− 1.7	− 2.7	− 2.7	− 2.7	− 2.8	− 3.1	− 3.7	− 3.9	− 2.78
11 a. m	**− 8.0**	**− 7.6**	**− 6.6**	**− 6.6**	**− 9.0**	**− 9.4**	**− 8.4**	**− 8.0**	**− 8.1**	**− 9.7**	**− 8.8**	**− 9.0**	**− 8.26**
10-11 a. m	− 2.4	− 2.7	− 1.8	− 1.7	− 2.2	− 1.5	− 1.9	− 1.9	− 1.8	− 2.1	− 1.8	− 2.5	− 2.02
12 noon	**− 10.2**	**− 9.3**	**− 9.2**	**− 8.6**	**− 11.0**	**− 10.4**	**− 9.6**	**− 9.6**	**− 9.4**	**− 11.3**	**− 10.2**	**− 10.1**	**− 9.91**
11-12 noon	− 2.2	− 1.7	− 2.6	− 2.0	− 2.0	− 1.0	− 1.2	− 1.6	− 1.3	− 1.6	− 1.4	− 1.1	− 1.65
1 p. m	**− 12.3**	**− 12.0**	**− 12.2**	**− 12.3**	**− 12.9**	**− 11.5**	**− 10.6**	**− 10.4**	**− 10.2**	**− 12.0**	**− 11.2**	**− 11.6**	**− 11.60**
12-1 p. m	− 2.1	− 2.7	− 3.0	− 3.7	− 1.9	− 1.1	− 1.0	− 0.8	− 0.8	− 0.7	− 1.0	− 1.5	− 1.69
2 p. m	**− 13.7**	**− 13.5**	**− 15.2**	**− 14.5**	**− 13.3**	**− 11.9**	**− 10.5**	**− 10.5**	**− 9.7**	**− 11.7**	**− 11.3**	**− 11.7**	**− 12.29**
1-2 p. m	− 1.1	− 1.5	− 3.0	− 2.2	− 0.4	− 0.4	0.1	− 0.1	0.5	0.3	− 0.1	− 0.1	− 0.69
3 p. m	**− 13.9**	**− 15.2**	**− 16.1**	**− 15.5**	**− 11.9**	**− 10.6**	**− 10.0**	**− 9.2**	**− 8.5**	**− 10.9**	**− 10.1**	**− 11.2**	**− 11.92**
2-3 p. m	− 0.2	− 1.7	− 0.9	− 1.0	1.1	1.3	0.5	1.3	1.2	0.8	1.2	0.5	0.37

TABLE XLI.—*Differences between the hourly averages compared with each other and between the same hourly averages and the monthly averages of relative humidity in Manila*—Continued.

Hour.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
4 p. m	−13.2	−15.1	−15.2	−14.4	−9.2	−8.7	−7.8	−7.0	−6.4	−8.8	−8.6	−10.3	−10.39
3–4 p. m	0.7	0.1	0.9	1.1	2.7	1.9	2.2	2.2	2.1	2.1	1.5	0.9	1.53
5 p. m	−10.9	−13.3	−12.7	−11.4	−6.6	−6.4	−5.1	−5.3	−3.8	−6.0	−5.6	−7.3	−7.86
4–5 p. m	2.3	1.8	2.5	3.0	2.6	2.3	2.7	1.7	2.6	2.8	3.0	3.0	2.53
6 p. m	−6.7	−8.7	−8.6	−7.3	−3.4	−3.3	−2.9	−2.8	−1.2	−2.4	−2.3	−3.2	−4.40
5–6 p. m	4.2	4.6	4.1	4.1	3.2	3.1	2.2	2.5	2.6	3.6	3.3	4.1	3.46
7 p. m	−2.3	−4.3	−3.8	−3.5	−0.9	−0.4	−0.2	−0.5	0.4	−0.5	−0.2	−0.4	−1.38
6–7 p. m	4.4	4.4	4.8	3.8	2.5	2.9	2.7	2.3	1.6	1.9	2.1	2.8	3.02
8 p. m	0.4	−0.8	−0.6	−0.1	1.3	1.7	1.3	1.1	1.8	1.2	1.5	1.1	0.83
7–8 p. m	2.7	3.5	3.2	3.4	2.2	2.1	1.5	1.6	1.4	1.7	1.7	1.5	2.21
9 p. m	2.3	1.9	2.2	2.5	3.2	3.5	2.8	2.6	3.2	3.3	2.8	2.7	2.75
8–9 p. m	1.9	2.7	2.8	2.6	1.9	1.8	1.5	1.5	1.4	2.1	1.3	1.6	1.92
10 p. m	3.7	3.7	4.4	4.2	4.5	4.7	4.1	4.0	4.0	4.5	3.9	3.5	4.10
9–10 p. m	1.4	1.8	2.2	1.7	1.3	1.2	1.3	1.4	0.8	1.2	1.1	0.8	1.35
11 p. m	5.0	5.2	6.0	5.9	5.8	5.7	5.5	5.5	4.8	5.6	4.9	4.7	5.39
10–11 p. m	1.3	1.5	1.6	1.7	1.3	1.0	1.4	1.5	0.8	1.1	1.0	1.2	1.29
12 midnight	6.3	6.4	7.0	7.2	7.1	6.7	6.1	5.8	5.4	6.8	5.6	5.3	6.31
11–12 midnight	1.3	1.2	1.0	1.3	1.3	1.0	0.6	0.3	0.6	1.2	0.7	0.6	0.92
Average	8.2	8.9	9.0	8.6	7.6	7.2	6.3	6.1	5.6	7.1	6.5	7.0	7.31
Average	2.3	2.5	2.6	2.6	2.1	1.9	1.7	1.6	1.5	1.9	1.8	1.9	1.98

ANNUAL VARIATION OF THE TENSION OF THE AQUEOUS VAPOR AT MANILA

1883-1898



V.—ANNUAL VARIATION OF THE TENSION OF AQUEOUS VAPOR AT MANILA.

Table XLII contains the monthly and annual averages of aqueous vapor at Manila during the period 1883 to 1898. From the normal averages which are at the end of this table the curve in Plate XXI has been drawn.

TABLE XLII—*Monthly and annual averages of the tension of aqueous vapor in Manila during the period of 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1883	18.1	17.6	19.5	20.9	22.3	22.0	21.9	22.8	22.1	20.7	19.2	18.6	20.4
1884	16.5	17.3	17.7	18.8	21.0	21.5	21.6	21.5	21.5	20.5	19.1	17.7	19.6
1885	16.8	17.0	17.2	18.2	20.7	20.9	21.6	21.9	21.9	21.6	20.3	18.7	19.7
1886	18.7	16.9	16.9	20.9	21.8	22.5	22.5	22.4	23.0	22.0	20.2	19.3	20.6
1887	19.4	18.0	20.4	21.3	23.0	23.5	23.8	22.6	22.7	21.1	21.3	20.9	21.5
1888	19.5	17.3	19.2	20.9	21.5	22.9	22.8	22.8	22.6	21.9	21.2	20.1	21.1
1889	20.6	20.4	20.3	20.3	21.6	23.1	22.6	22.5	23.3	22.4	21.5	20.0	21.6
1890	19.0	18.2	18.3	20.3	22.1	21.9	22.1	22.0	22.2	21.4	19.3	18.7	20.5
1891	17.3	16.4	17.9	19.2	21.3	22.8	22.3	22.4	22.7	21.1	20.5	19.2	20.3
1892	18.2	17.9	18.9	18.7	21.8	22.0	22.5	22.1	22.3	21.6	20.2	18.4	20.4
1893	17.0	17.3	18.0	20.0	22.1	21.4	22.4	22.9	22.3	21.0	19.3	18.6	20.2
1894	17.2	16.8	18.1	18.8	21.6	22.3	22.1	22.5	22.3	21.7	19.4	18.9	20.1
1895	17,8	17.2	18.4	20.6	23.3	23.2	22.7	22.4	22.7	21.1	19.8	18.1	20.6
1896	16.8	17.8	18.9	18.9	22.9	23.3	22.7	22.6	22.8	22.2	20.8	18.9	20.7
1897	18.3	18.0	18.9	20.0	23.2	23.0	22.5	22.6	22.8	22.2	21.8	20.0	21.1
1898	18.8	19.5	19.9	21.3	22.5	23.0	22.3	22.4	22.2	22.2	21.3	19.3	21.2
Average	18.1	17.7	18.7	19.9	22.0	22.5	22.4	22.4	22.5	21.6	20.3	19.1	20.6

NORMAL AVERAGES OF THE DIFFERENT MONTHS OF THE YEAR.

According to this data we see that vapor tension remains the same during February, increases from then until June, preserves about the same tension during June, July, August, and September, and diminishes from September to February.

THE NORMAL AVERAGES OF EACH MONTH COMPARED WITH THE ANNUAL NORMAL AVERAGES.

The annual average is 20.6. The gradation with which the normal values of each month of the year separate from this is shown in the following table:

Month.	Monthly average.	Difference.
	mm.	*mm.*
January	18.1	−2.5
February	17.7	−2.9
March	18.7	−1.9
April	19.9	− .7
May	22.0	+1.4
June	22.5	+1.9
July	22.4	+1.8
August	22.4	+1.8
September	22.5	+1.9
October	21.6	+1.0
November	20.3	− .3
December	19.1	−1.5
Annual average	20.6	....

EXTREME ANNUAL AVERAGES.

The values of the annual averages of the period 1883 to 1898 vary between 19.6 (1884) and 21.6 (1889); the difference therefore being 2.

COMPARISON BETWEEN THE NORMAL AVERAGES AND THE EXTREME AVERAGES OF EACH MONTH.

The maximum and minimum averages of each month vary more or less from the normal average, as is indicated in the following table:

Month.	Normal average.	Maximum difference.	
		Positive.	Negative.
	mm.	*mm.*	*mm.*
January	18.1	2.5 (1889)	1.6 (1884)
February	17.7	2.7 (1889)	1.3 (1891)
March	18.7	1.7 (1887)	1.8 (1886)
April	19.9	1.4 (1887 and 1898)	1.7 (1885)
May	22.0	1.3 (1895)	1.3 (1885)
June	22.5	1.0 (1887)	1.6 (1885)
July	22.4	1.4 (1887)	.8 (1884 and 1885)
August	22.4	.5 (1893)	.9 (1884)
September	22.5	.8 (1889)	1.0 (1884)
October	21.6	.8 (1889)	1.1 (1884)
November	20.3	1.5 (1897)	1.2 (1884)
December	19.1	1.8 (1887)	1.4 (1884)

The maximum positive differences, 2.7 and 2.5, correspond to the months of February and January of 1889; the maximum negative difference, 1.8, to the month of March, 1886.

VI.—MONTHLY AND ANNUAL MAXIMA AND MINIMA OF THE TENSION OF AQUEOUS VAPOR AT MANILA.

In Tables XLIII and XLIV we give the maxima and minima of the tension of aqueous vapor as noted in this observatory during the period of sixteen years from 1883 to 1898, concerning which it should be remembered that the same is true of these observations as was said of those concerning humidity at the beginning of paragraph 2.

TABLE XLIII.—*Monthly and annual maxima of the tension of aqueous vapor at Manila during the period of 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual maximum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1883	24.4	22.6	24.5	26.6	25.5	25.0	25.5	26.0	24.9	25.5	24.6	25.0	26.0
1884	22.3	24.8	23.6	23.9	24.8	24.6	25.0	24.6	24.8	24.5	23.6	22.6	25.0
1885	21.8	22.0	23.6	24.2	25.5	24.5	24.6	24.7	25.0	25.2	25.4	23.3	25.5
1886	23.9	23.0	23.0	28.9	25.7	25.9	27.1	27.5	27.2	26.7	24.7	25.3	28.9
1887	24.4	24.8	26.4	26.4	27.1	27.6	27.3	26.5	25.9	24.3	25.3	25.6	27.6
1888	26.0	22.5	23.6	26.7	25.0	26.0	25.5	25.6	25.5	25.6	24.6	23.9	26.7
1889	25.5	25.2	29.0	26.2	27.0	27.2	25.6	25.4	26.4	26.1	25.8	26.0	29.0
1890	23.7	23.4	23.6	25.1	25.4	25.5	25.4	25.0	24.8	25.3	23.8	22.2	25.5
1891	22.3	21.7	23.9	24.4	26.9	26.4	25.0	24.8	24.9	25.8	23.8	23.6	26.9
1892	22.2	23.2	23.4	23.0	25.3	25.3	25.3	25.3	26.0	25.3	24.8	24.3	26.0
1893	22.2	22.0	22.2	25.8	26.1	24.4	25.0	25.4	25.5	24.4	23.4	23.8	26.1
1894	22.8	21.1	23.3	24.6	25.4	25.7	25.0	25.6	25.6	25.5	24.8	24.2	25.7
1895	22.2	23.2	23.3	26.1	26.7	27.1	25.1	25.2	24.9	25.9	24.5	24.7	27.1
1896	23.3	23.9	24.2	24.6	26.2	27.0	25.9	26.1	25.7	25.8	24.6	26.8	27.0
1897	25.5	23.4	24.0	25.6	28.5	26.3	25.3	26.1	26.0	25.8	25.0	24.2	28.5
1898	24.3	23.1	25.0	24.6	26.5	26.1	25.3	25.2	25.1	25.9	25.5	23.9	26.5
Average	23.6	23.1	24.2	25.3	26.1	25.9	25.5	25.6	25.5	25.5	24.6	24.3	26.8

TABLE XLIV.—*Monthly and annual minima of the tension of aqueous vapor at Manila during the period of 1883 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual minimum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1883	13.6	12.9	13.7	17.2	17.6	18.6	18.3	18.5	19.6	14.4	14.5	12.6	12.6
1884	11.9	12.6	10.8	12.6	15.4	18.6	17.2	17.9	15.6	14.2	11.2	11.5	10.8
1885	13.7	11.6	10.6	13.9	13.2	15.8	18.0	19.1	17.5	16.4	15.3	12.3	10.6
1886	13.1	11.8	10.4	14.4	16.0	18.5	17.8	17.8	19.2	18.1	14.1	15.2	10.4
1887	14.4	12.0	14.5	16.6	17.1	19.7	19.9	18.7	18.5	16.7	18.1	15.5	12.0
1888	14.8	9.7	12.0	12.0	12.9	19.4	19.8	20.5	19.6	16.2	16.7	12.1	9.7
1889	14.0	15.3	13.7	14.4	15.5	17.0	19.1	19.6	19.2	19.5	17.3	15.4	13.7
1890	12.9	14.4	12.7	16.8	17.8	17.8	19.1	18.5	18.3	14.9	14.8	14.3	12.7
1891	12.3	11.2	13.2	14.4	15.3	20.3	19.4	19.8	19.4	16.9	12.8	14.1	11.2
1892	15.4	13.7	12.5	13.4	16.6	14.9	20.0	19.0	18.0	18.1	15.2	11.9	11.9
1893	12.0	13.4	13.0	14.4	18.3	17.7	19.0	20.0	19.0	15.3	15.5	14.9	12.0
1894	12.6	11.8	13.1	12.7	14.8	19.4	19.8	19.4	18.0	17.6	12.7	12.0	11.8
1895	14.0	13.4	13.6	15.3	18.0	19.6	17.9	17.5	20.0	17.2	15.1	13.2	13.2
1896	13.2	14.0	13.0	12.5	17.7	20.0	19.2	19.8	18.8	18.6	16.8	14.5	12.5
1897	12.0	13.9	9.9	12.8	18.2	17.1	19.0	20.3	19.9	18.6	16.5	15.4	9.9
1898	12.1	14.5	14.6	16.5	17.6	19.8	19.9	19.0	18.2	19.0	17.8	14.7	12.1
Average	13.3	12.9	12.6	14.4	16.4	18.4	19.0	19.1	18.7	17.0	15.3	13.7	11.7

RELATION BETWEEN THE AVERAGE MONTHLY VALUES OF THE MAXIMA AND MINIMA OF THE TENSION OF AQUEOUS VAPOR.

According to Table XLIII, the averages of monthly maxima are included between 25.3 and 26.1 in the months April to October, and between 23.1 and 24.6 in the months from November to March, inclusive. The greatest average, 26.1, corresponds to the month of May, and the smallest, 23.1, to the month of February. Very different is the relation existing between the values of the average monthly minima. The greatest average, 19.1, is that for the month of August, and the smallest, 12.6, is for the month of March. Following this latter in ascending order come the averages for February, January, December, April, November, May, October, June, September, July, and August.

Monthly maxima and minima for all the period may be seen in the following table:

Month.	Maxima.	Minima.
January	26.0 (1888)	11.9 (1884)
February	25.2 (1889)	9.7 (1888)
March	29.0 (1889)	9.9 (1897)
April	28.9 (1886)	12.0 (1888)
May	28.5 (1897)	12.9 (1888)
June	27.6 (1887)	14.9 (1892)
July	27.3 (1887)	17.2 (1884)
August	27.5 (1886)	17.5 (1895)
September	27.2 (1886)	15.6 (1884)
October	26.7 (1886)	14.2 (1884)
November	25.8 (1889)	11.2 (1884)
December	26.8 (1896)	11.5 (1884)

MAXIMUM AND MINIMUM FOR ALL THE PERIOD.

The maximum and minimum during all the period are 29.0 and 9.7, respectively, observed on the 30th of March, 1889, and the 4th of February, 1888. The difference between these two extremes is 19.3. Very near to these are the annual maximum for 1886, 28.9, and the annual minimum for 1897, 9.9.

DISTRIBUTION OF THE ANNUAL MAXIMA AND MINIMA IN THE DIFFERENT MONTHS OF THE YEAR.

The following table shows the monthly frequency of the 16 annual maxima and minima:

Maxima—	
March	1
April	2
May	5
June	5
July	1
August	1
September	1

Minima—	
January	2
February	4
March	6
April	1
December	3

It happens that all the annual maxima and minima fall within the months March to September and December to April, respectively. The greater frequency of maxima corresponds to the months May to June, and of minima those of March and February.

VII.—MONTHLY AVERAGES OF THE DAILY MAXIMA AND MINIMA OF THE TENSION OF THE AQUEOUS VAPOR AT MANILA—AVERAGE DAILY VARIATION.

In Tables XLV and XLVI we give the monthly and annual averages deduced from the maxima and minima daily tension of the aqueous vapor during the periods from 1885 to 1898. The difference between the averages of those two tables represents the average monthly variation of this element, which is included in Table XLVII.

Table XLV.—*Monthly and annual averages of the daily maxima of the tension of aqueous vapor at Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1885	18.8	19.4	19.8	20.6	23.2	22.9	23.0	23.4	23.5	23.5	22.3	20.8	21.8
1886	21.2	19.1	19.5	23.3	23.9	24.2	24.2	24.1	24.7	23.9	22.0	21.2	22.6
1887	22.0	20.2	22.7	23.4	25.3	25.5	25.5	24.2	24.2	22.8	22.9	23.1	23.5
1888	22.2	19.5	21.2	23.3	23.5	24.4	24.3	24.1	24.0	23.8	23.2	22.0	23.0
1889	22.9	23.0	22.8	22.7	23.7	25.0	24.3	23.9	24.9	24.2	23.2	21.8	23.5
1890	20.9	20.3	20.4	22.1	23.8	23.6	23.8	23.6	23.5	23.0	21.2	20.5	22.2
1891	18.9	18.2	20.0	21.2	23.7	24.6	23.7	23.7	24.0	23.2	21.7	21.1	22.0
1892	19.9	19.9	20.9	20.8	23.7	23.8	24.0	23.5	23.9	23.1	22.1	20.2	22.2
1893	18.8	19.4	19.7	22.1	23.8	23.1	23.8	24.3	23.8	22.6	20.9	20.2	21.9
1894	19.1	19.3	20.2	20.7	23.5	23.9	23.4	24.1	23.8	23.6	21.6	20.5	22.0
1895	19.9	19.1	20.5	22.8	25.0	24.9	24.2	23.9	23.9	23.3	21.5	20.1	22.4
1896	18.8	20.0	21.0	21.6	24.6	25.1	24.3	24.0	24.4	23.9	23.0	21.6	22.7
1897	20.8	20.3	21.2	23.4	25.3	24.9	24.2	24.2	24.5	23.8	23.6	21.7	23.2
1898	20.6	21.5	21.9	23.2	24.5	24.7	23.8	23.8	23.9	24.0	22.9	21.2	23.0
Average	20.3	19.9	20.8	22.2	24.1	24.3	24.0	23.9	24.1	23.5	22.3	21.1	22.6

TABLE XLVI.—*Monthly and annual averages of the daily minima of the tension of aqueous vapor at Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1885	15.2	14.8	14.9	16.2	17.9	19.2	20.1	20.3	20.0	19.5	18.6	16.6	17.8
1886	16.4	15.0	14.5	18.3	19.7	20 5	20.5	20.1	21.4	20.3	18.6	17.7	18.6
1887	17.3	15.9	18.4	19.3	21.0	21.6	22.1	21.2	21.1	19.8	19.9	19.1	19.7
1888	17.1	15.2	17.0	18.3	19.0	21.5	21.6	21.6	21.1	20.3	19.3	18.0	19.2
1889	18.4	18.1	17.7	17.8	19.2	20.8	20.9	21.1	21.4	20.9	20.2	18.4	19.6
1890	17.1	16.4	15.6	18.4	20.4	20.1	20.3	20.4	21.0	19.7	17.6	16.8	18.7
1891	15.7	14.5	15.9	16.9	18.8	21.2	21.2	21.2	21.3	19.6	18.5	17.6	18.5
1892	16.6	15.9	16.9	16.5	19.6	20.3	21.1	20.5	20.8	20.0	18.8	17.0	18.7
1893	15.3	15.3	16.2	17.9	20.2	19.7	20.8	21.6	20.8	19.6	17.8	17.3	18.5
1894	15.5	14.7	16.2	16.5	19.5	21.0	20.7	21.0	20.7	20.2	17.5	17.3	18.4
1895	16.1	15.5	16.5	18.4	21.6	21.5	21.0	20.9	21.4	19.8	18.2	16.4	18.9
1896	15.1	15.9	16.9	16.2	21.4	21.7	21.2	21.2	21.3	20.6	18.6	16.8	18.9
1897	16.1	15.9	16.5	17.4	21.3	21.1	20.8	21.1	21.6	20.6	20.1	18.4	19.2
1898	16.9	17.7	17.4	19.5	20.4	21.3	21.0	20.9	20.4	20.8	20.0	17.7	19.5
Average	16.3	15.8	16.5	17.7	20.0	20.8	21.0	20.9	21.0	20.1	18.8	17.5	18.9

TABLE XLVII.—*Average of the monthly variation of the tension of the aqueous vapor in Manila during the period 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1885	3.6	4.6	4.9	4.4	5.3	3.7	2.9	3.1	3.5	4.0	3.7	4.2	4.0
1886	4.8	4.1	5.0	5.0	4.2	3.7	3.7	4.0	3.3	3.6	3.4	3.5	4.0
1887	4.7	4.3	4.3	4.1	4.3	3.9	3.4	3.0	3.1	3.0	3.0	4.0	3.8
1888	5.1	4.3	4.2	5.0	4.5	2.9	2.7	2.5	2.9	3.5	3.9	4.0	3.8
1889	4.5	4.9	5.1	4.9	4.5	4.2	3.4	2.8	3.5	3.3	3.0	3.4	4.0
1890	3.8	3.9	4.8	3.7	3.4	3.5	3.5	3.2	2.5	3.3	3.6	3.7	3.6
1891	3.2	3.7	4.1	4.3	4.9	3.4	2.5	2.5	2.7	3.6	3.2	3.5	3.5
1892	3.3	4.0	4.0	4.3	4.1	3.5	2.9	3.0	3.1	3.1	3.3	3.2	3.5
1893	3.5	4.1	3.5	4.2	3.6	3.4	3.0	2.7	3.0	3.0	3.1	2.9	3.3
1894	3.6	4.6	4.0	4.2	4.0	2.9	2.7	3.1	3.1	3.4	4.1	3.2	3.6
1895	3.8	3.6	4.0	4.4	3.4	3.4	3.2	3.0	2.5	3.5	3.3	3.7	3.5
1896	3.7	4.1	4.1	5.4	3.2	3.4	3.1	2.8	3.1	3.3	4.4	4.8	3.8
1897	4.7	4.4	4.7	6.0	4.0	3.8	3.4	3.1	2.9	3.2	3.5	3.3	3.9
1898	3.7	3.8	4.5	3.7	4.1	3.4	2.8	2.9	3.5	3.2	2.9	3.5	3.5
Average	4.0	4.2	4.4	4.5	4.1	3.5	3.1	3.0	3.1	3.4	3.5	3.6	3.7

RELATION BETWEEN THE AVERAGE MONTHLY MAXIMA AND MINIMA OF THE TENSION OF THE AQUEOUS VAPOR.

According to the normal values of the average maxima deduced from Table XLV it will be seen that the greatest maximum occurs in June, it is felt but very little less during the months of May, July, August, and September, is considerably less during October, November, April, and December, and begins to reach an end in March, January, and February. The difference between the average monthly extremes which in February are 19.9 and in June 24.3 is 4.4.

Between the normal averages of the minimum there is observed a very similar gradation to that which we have indicated for the average of the maxima. The maximum is reached in February and increases gradually from February to July, which remains almost of the same tension from July to September, beginning to diminish gradually from September to February. The normal extremes are 15.8 in February and 21.0 in July and September, the difference being 5.2.

AVERAGE OF THE MAXIMA AND AVERAGE OF THE MINIMA OF ALL THE PERIODS.

The average deduced from all daily maxima of the period 1885 to 1898 is 22.6, and the average deduced from all the minimum is 18.9. The difference is only 3.7 degrees, which represents also the average annual variation of the tension of the aqueous vapor in Manila. The greatest annual average of the maxima is 23.5 (1887 and 1889) and the least annual average of the minima 17.8 (1885), the difference being 5.7.

RELATION BETWEEN THE AVERAGE DAILY VARIATIONS OF THE DIFFERENT MONTHS OF THE YEAR.

If we fix now on the result which we find in Table XLVII, we see that the months in which occur the greatest average daily variations of the tension of the aqueous vapor are the months of March and April, and in those months there is also the greatest average variation of the temperature and the relative humidity. In May there is already a diminution of the extent of those variations which continues until the month of August, when it corresponds to the minimum average variations. This is maintained with little difference throughout the period from July to September, inclusive; beginning with October it increases gradually until the months of March and April.

The difference between the two normal extreme variations, 4.5 in April and 3.0 in August, is 1.5.

EXTENT OF THE ANNUAL AVERAGE DAILY VARIATIONS. ANNUAL AVERAGES AND MONTHLY EXTREMES OF ALL PERIODS.

The average annual extent of the daily variation is 3.7. The annual extreme averages of all periods, 1885–1898, 4.0 (1885, 1886, and 1889) and of 3.3 in 1893. The maximum average monthly extent of the daily variations was for April, 1897, when it reached the value of 6.0, while in July and August, 1891, and August, 1888, and September, 1890 and 1895, the minimum was 2.5.

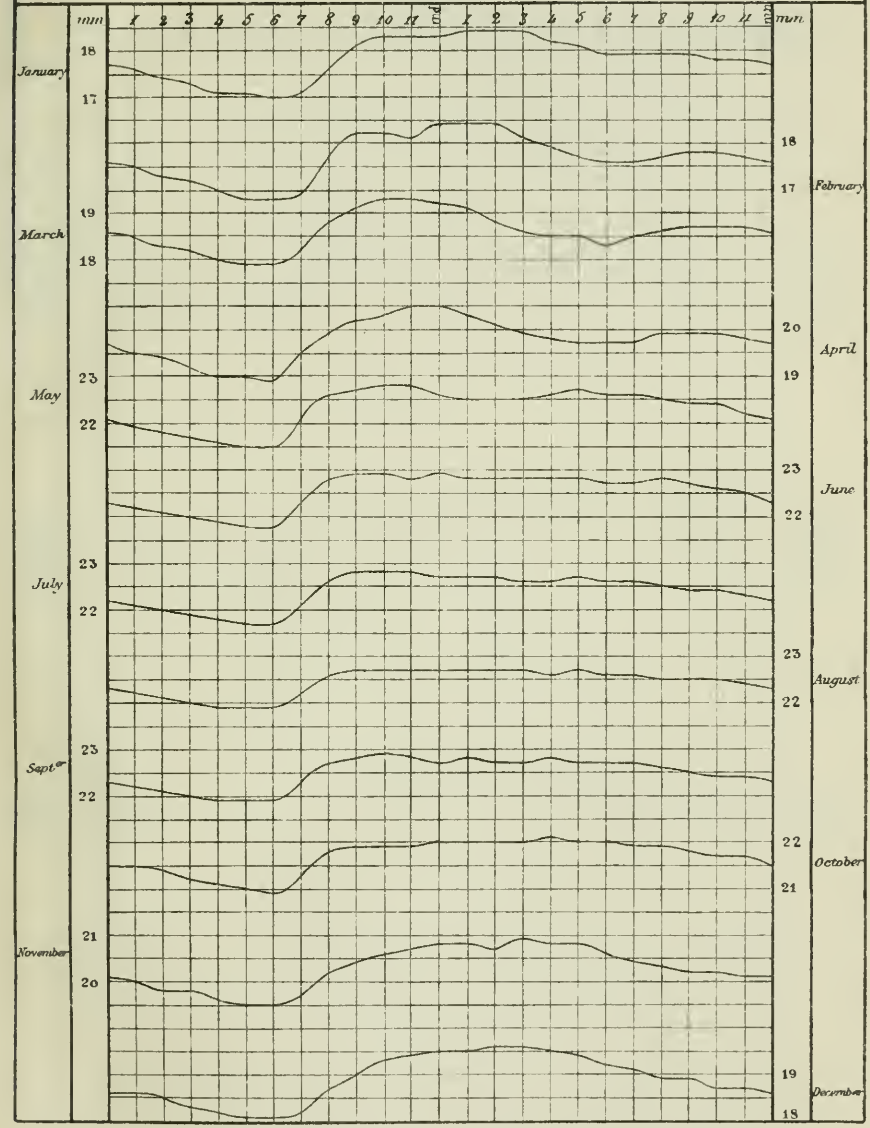
VIII.—DAILY VARIATION OF THE TENSION OF THE AQUEOUS VAPOR IN MANILA.

The Table XLVIII covers the hourly, monthly, semiannual, and annual averages of the tension of the aqueous vapor in Manila deduced from the period 1890–1898 with those which have been traced by the curves of Plates XXII and XXIII.

PLATE XXII.

DAILY VARIATION OF THE TENSION OF THE AQUEOUS VAPOR AT MANILA

1890-1898



DAILY VARIATION OF THE TENSION OF THE AQUEOUS VAPOR AT MANILA

1890-1898

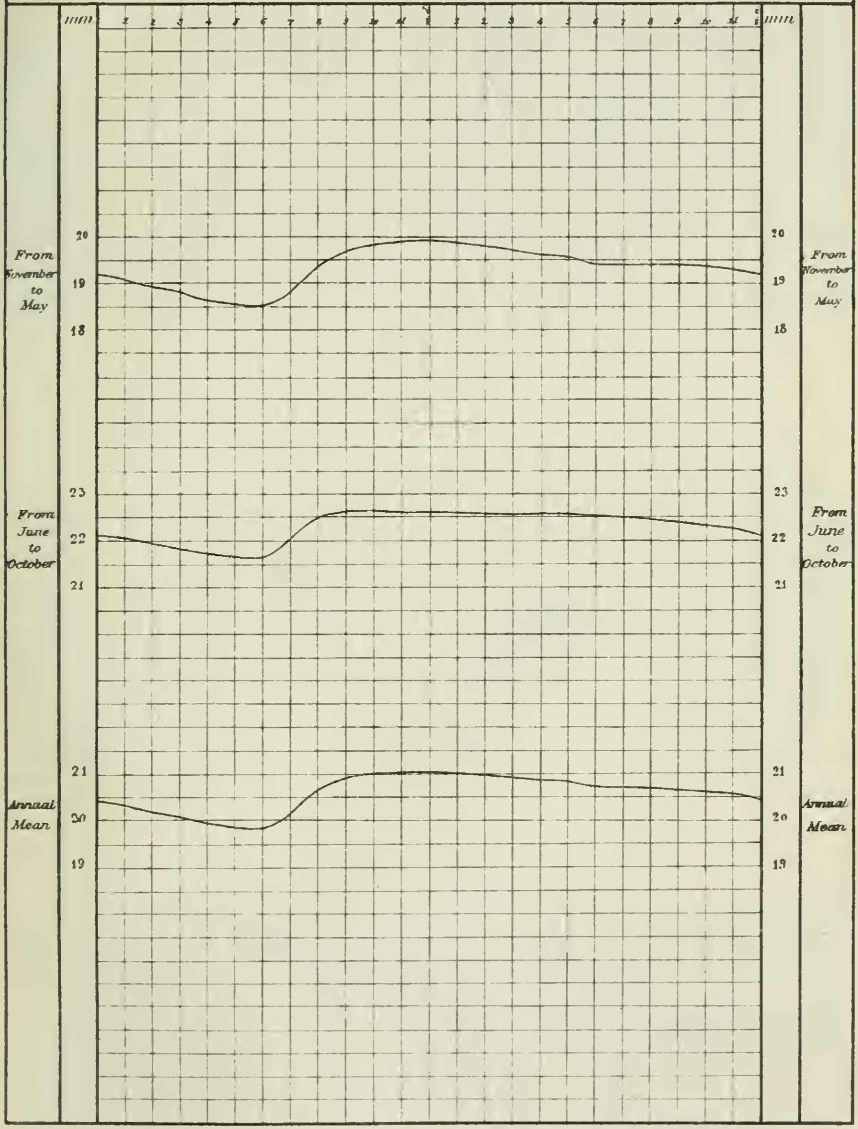


TABLE XLVIII.—*Hourly, monthly, semiannual, and annual averages of the tension of the aqueous vapor in Manila obtained from the period 1890–1898.*

FORENOON.

Month.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 noon.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	17.6	17.4	17.3	17.1	17.1	17.0	17.1	17.6	18.1	18.3	18.3	18.3
February	17.5	17.3	17.2	17.0	16.8	16.8	16.9	17.7	18.2	18.2	18.1	18.4
March	18.5	18.3	18.2	18.0	17.9	17.9	18.2	18.8	19.1	19.3	19.3	19.2
April	19.5	19.4	19.2	19.0	19.0	18.9	19.5	19.9	20.2	20.3	20.5	20.5
May	21.9	21.8	21.7	21.6	21.5	21.5	22.1	22.6	22.7	22.8	22.8	22.6
June	22.2	22.1	22.0	21.9	21.8	21.8	22.3	22.8	22.9	22.9	22.8	22.9
July	22.1	22.0	21.9	21.8	21.7	21.7	22.1	22.6	22.8	22.8	22.8	22.7
August	22.2	22.1	22.0	21.9	21.9	21.9	22.2	22.6	22.7	22.7	22.7	22.7
September	22.2	22.1	22.0	21.9	21.9	21.9	22.3	22.7	22.8	22.9	22.8	22.7
October	21.5	21.4	21.2	21.1	21.0	20.9	21.3	21.8	21.9	21.9	21.9	22.0
November	20.0	19.8	19.8	19.6	19.5	19.5	19.7	20.2	20.4	20.6	20.7	20.8
December	18.6	18.5	18.3	18.2	18.1	18.1	18.2	18.7	19.0	19.3	19.4	19.5
Average	20.32	20.18	20.07	19.93	19.85	19.83	20.16	20.67	20.90	21.00	21.01	21.03
Average November to May	19.09	18.93	18.81	18.64	18.56	18.53	18.81	19.36	19.67	19.83	19.87	19.90
Average June to October	22.04	21.94	21.82	21.72	21.66	21.64	22.04	22.50	22.62	22.64	22.60	22.60

AFTERNOON.

Month.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	Mean.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	18.4	18.4	18.4	18.2	18.1	17.9	17.9	17.9	17.9	17.8	17.8	17.7	17.8
February	18.4	18.4	18.1	17.9	17.7	17.6	17.6	17.7	17.8	17.8	17.7	17.6	17.7
March	19.1	18.8	18.6	18.5	18.5	18.3	18.5	18.6	18.7	18.7	18.7	18.6	18.6
April	20.3	20.1	19.9	19.8	19.7	19.7	19.7	19.9	19.9	19.9	19.8	19.7	19.8
May	22.5	22.5	22.5	22.6	22.7	22.6	22.6	22.5	22.4	22.4	22.2	22.1	22.3
June	22.8	22.8	22.8	22.8	22.8	22.7	22.7	22.8	22.7	22.6	22.5	22.3	22.5
July	22.7	22.7	22.6	22.6	22.7	22.6	22.6	22.5	22.4	22.4	22.3	22.2	22.4
August	22.7	22.7	22.7	22.6	22.7	22.6	22.6	22.5	22.5	22.5	22.4	22.3	22.4
September	22.8	22.7	22.7	22.8	22.7	22.7	22.7	22.6	22.5	22.4	22.4	22.3	22.5
October	22.0	22.0	22.0	22.1	22.0	22.0	21.9	21.9	21.8	21.7	21.7	21.5	21.7
November	20.8	20.7	20.9	20.8	20.8	20.6	20.4	20.3	20.2	20.2	20.1	20.1	20.3
December	19.5	19.6	19.6	19.5	19.4	19.2	19.1	18.9	18.9	18.7	18.7	18.6	18.9
Average	21.00	20.95	20.90	20.85	20.82	20.71	20.69	20.68	20.64	20.59	20.53	20.42	20.58
Average, November to May	19.86	19.79	19.71	19.61	19.56	19.41	19.40	19.40	19.40	19.36	19.29	19.20	19.34
Average, June to October	22.60	22.58	22.56	22.58	22.58	22.52	22.50	22.46	22.38	22.32	22.26	22.12	22.30

DAILY COURSE OF THE TENSION OF THE AQUEOUS VAPOR.

If we look at the curves on Plate XXII, which represent the partial averages of each month, we see in all of them some irregularity of movement, though of little importance, especially during the afternoon and early hours of the night; nevertheless, in the annual curve, as in the semiannual curves of Plate XXIII, almost all irregularity disappears, and we suppose it would disappear also in the similar monthly curves, although there can be traced the value of the averages deduced from a great number of years of observation.

From this supposition we shall be able to form a sufficiently complete idea of the average daily course of this element, examining these annual and semiannual curves, or that which is the same, the annual and semiannual averages, which will be seen at the end of Table XLVIII. According to these annual averages it can be said that this daily variation consists in a simple oscillation whose minimum, which is usually observed at daybreak, coincides with the minimum temperature and the maximum humidity, and whose maximum corresponds to 12 noon.

The greatest increase of tension is observed from 6 to 10 a. m., remaining almost stationary from that hour until 1 in the afternoon. At 2 it begins to diminish, but in an extraordinarily slow and almost insensible manner until 11 or 12 at night, when it decreases with greater rapidity until it reaches the minimum at dawn.

In the semiannual averages it is seen that the minimum corresponds in both periods at 6 a. m., but in the period from November to May the tension reaches its maximum at the hour of 12 midnight, remaining almost stationary from 11 a. m. until 1 p. m., while in the other period from June to October the maximum is reached at 10 a. m., remaining almost stationary from 9 a. m. until 5 in the afternoon, inclusive.

In regard to the different curves of each month we will only indicate those of November to April which are peculiar for a somewhat notable increase, which is not to be seen in the curves of the other months. This decrease occurs from 5 to 9 a. m. in November, from 3 to 8 in December, from 3 to 6 in January, from 2 to 6 in February, from 1 to 4 in March, and from 12 m. to 4 p. m. in April. Besides, it is observed in February to April that the tension begins to increase somewhat at night; from 7 to 9 in February, from 6 to 9 in March, and from 7 to 8 in April.

HOURS OF THE MAXIMUM AND MINIMUM TENSION AND EXTENT OF THE VARIATION OF THE AQUEOUS VAPOR IN THE DIFFERENT MONTHS OF THE YEAR.

Following the same method which we have adopted for the atmospheric pressure, temperature, and humidity, we give in the following table the hours of the minimum and maximum tension, with the extent of the monthly, semiannual, and annual variation, the data for which we take from the monthly, semiannual, and annual averages of Table XLVIII.

	Hours of distention.		Amplitude of the oscillation.
	Minimum.	Maximum.	
January	6 a. m	1, 2, 3 p. m	1.4
February	5, 6 a. m	12 noon; 1, 2 p. m	1.6
March	5, 6 a. m	10, 11 a. m	1.4
April	6 a. m	11 a. m.; 12 noon	1.6
May	5, 6 a. m	10, 11 a. m	1.3
June	5, 6 a. m	9, 10 a. m.; 12 noon	1.1
July	5, 6 a. m	9, 10, 11 a. m	1.1
August	4, 5, 6 a. m	9, 10, 11 a. m.; 12 noon; 1, 2, 3, 5 p. m.	.8
September	4, 5, 6 a. m	10 a. m	1.0
October	6 a. m	4 p. m	1.2
November	5, 6 a. m	3 p. m	1.4
December	5, 6 a. m	2, 3 p. m	1.5
Average			1.3
Annual	6 a. m	12 noon	1.2
November to May	6 a. m	12 noon	1.37
June to October	6 a. m	10 a. m	1.0

Concerning this table it only remains for us to add to what has been briefly indicated above that, although in some months, as October, November, and December, the daily maximum is observed considerably after noon, considering the hourly averages and the curves of said months, it is seen that the tension increases rapidly from 9 to 10 in the morning; the increase observed after 10 o'clock, or about noon or afternoon, is very insignificant and almost imperceptible.

AVERAGE EXTENT OF THE ANNUAL AND SEMIANNUAL VARIATIONS.

The average annual extent of this variation of the tension of the aqueous vapor is 1.20 mm. The extent of the period from November to May is 1.37 mm., and that of the other period down to October does not exceed 1 mm. The months in which there is a lesser variation are August and September, which, as we have said, correspond also to the lesser variations of temperature and relative humidity.

TABLE XLIX.—*Difference between the hourly averages, as compared with themselves, and the same hourly averages compared with the monthly averages of the distension of the aqueous vapor in Manila.*

Hours.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1 a. m	**−0.2**	**−0.2**	**−0.1**	**−0.3**	**−0.4**	**−0.3**	**−0.3**	**−0.2**	**−0.3**	**−0.2**	**−0.3**	**−0.3**	**−0.26**
0–1 a. m	−0.1	−0.1	−0.1	−0.2	−0.2	−0.1	−0.1	−0.1	−0.1	0.0	−0.1	0.0	−0.10
2 a. m	**−0.4**	**−0.4**	**−0.3**	**−0.4**	**−0.5**	**−0.4**	**−0.4**	**−0.3**	**−0.4**	**−0.3**	**−0.5**	**−0.4**	**−0.40**
1–2 a. m	−0.2	−0.2	−0.2	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.2	−0.1	−0.14
3 a. m	**−0.5**	**−0.5**	**−0.4**	**−0.6**	**−0.6**	**−0.5**	**−0.5**	**−0.4**	**−0.5**	**−0.5**	**−0.5**	**−0.6**	**−0.51**
2–3 a. m	−0.1	−0.1	−0.1	−0.2	−0.1	−0.1	−0.1	−0.1	−0.1	−0.2	0.0	−0.2	−0.11
4 a. m	**−0.7**	**−0.7**	**−0.6**	**−0.8**	**−0.7**	**−0.6**	**−0.6**	**−0.5**	**−0.6**	**−0.6**	**−0.7**	**−0.7**	**−0.65**
3–4 a. m	−0.2	−0.2	−0.2	−0.2	−0.1	−0.1	−0.1	−0.1	−0.1	−0.1	−0.2	−0.1	−0.14
5 a. m	**−0.7**	**−0.9**	**−0.7**	**−0.8**	**−0.8**	**−0.7**	**−0.7**	**−0.5**	**−0.6**	**−0.7**	**−0.8**	**−0.8**	**−0.73**
4–5 a. m	0.0	−0.2	−0.1	0.0	−0.1	−0.1	−0.1	0.0	0.0	−0.1	−0.1	−0.1	−0.08
6 a. m	**−0.8**	**−0.9**	**−0.7**	**−0.9**	**−0.8**	**−0.7**	**−0.7**	**−0.5**	**−0.6**	**−0.8**	**−0.8**	**−0.8**	**−0.75**
5–6 a. m	−0.1	0.0	0.0	−0.1	0.0	0.0	0.0	0.0	0.0	−0.1	0.0	0.0	−0.02
7 a. m	**−0.7**	**−0.8**	**−0.4**	**−0.3**	**−0.2**	**−0.2**	**−0.3**	**−0.2**	**−0.2**	**−0.4**	**−0.6**	**−0.7**	**−0.42**
6–7 a. m	0.1	0.1	0.3	0.6	0.6	0.5	0.4	0.3	0.4	0.4	0.2	0.1	0.33
8 a. m	**−0.2**	**0.0**	**0.2**	**0.1**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**	**−0.1**	**−0.2**	**0.09**
7–8 a. m	0.5	0.8	0.6	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.51
9 a. m	**0.3**	**0.5**	**0.5**	**0.4**	**0.4**	**0.4**	**0.4**	**0.3**	**0.3**	**0.2**	**0.1**	**0.1**	**0.32**
8–9 a. m	0.5	0.5	0.3	0.3	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.23
10 a. m	**0.5**	**0.5**	**0.7**	**0.5**	**0.5**	**0.4**	**0.4**	**0.3**	**0.4**	**0.2**	**0.3**	**0.4**	**0.42**
9–10 a. m	0.2	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.10
11 a. m	**0.5**	**0.4**	**0.7**	**0.7**	**0.5**	**0.3**	**0.4**	**0.3**	**0.3**	**0.2**	**0.4**	**0.5**	**0.43**
10–11 a. m	0.0	−0.1	0.0	0.2	0.0	−0.1	0.0	0.0	−0.1	0.0	0.1	0.1	0.01
12 noon	**0.5**	**0.7**	**0.6**	**0.7**	**0.3**	**0.4**	**0.3**	**0.3**	**0.2**	**0.3**	**0.5**	**0.6**	**0.45**
11–12 noon	0.0	0.3	−0.1	0.0	−0.2	0.1	−0.1	0.0	−0.1	0.1	0.1	0.1	0.02
1 p. m	**0.6**	**0.7**	**0.5**	**0.5**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.5**	**0.6**	**0.42**
12–1 p. m	0.1	0.0	−0.1	−0.2	−0.1	−0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.03
2 p. m	**0.6**	**0.7**	**0.2**	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.4**	**0.7**	**0.37**
1–2 p. m	0.0	0.0	−0.3	−0.2	0.0	0.0	0.0	0.0	−0.1	0.0	−0.1	0.1	0.05
3 p. m	**0.6**	**0.4**	**0.0**	**0.1**	**0.2**	**0.3**	**0.2**	**0.3**	**0.2**	**0.3**	**0.6**	**0.7**	**0.32**
2–3 p. m	0.0	−0.3	−0.2	−0.2	0.0	0.0	−0.1	0.0	0.0	0.0	0.2	0.0	−0.05

4 p. m	**0.4**	**0.2**	**−0.1**	**0.0**	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.27**
3–4 p. m	−0.2	−0.2	−0.1	−0.1	0.1	0.0	0.0	−0.1	0.1	0.1	−0.1	−0.1	−0.05
5 p. m	**0.3**	**0.0**	**−0.1**	**−0.1**	**0.4**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.5**	**0.5**	**0.24**
4–5 p. m	−0.1	−0.2	0.0	−0.1	0.1	0.0	0.1	0.1	−0.1	−0.1	0.0	−0.1	−0.03
6 p. m	**0.1**	**−0.1**	**−0.3**	**−0.1**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.13**
5–6 p. m	−0.2	−0.1	−0.2	0.0	−0.1	−0.1	−0.1	−0.1	0.0	0.0	−0.2	−0.2	−0.11
7 p. m	**0.1**	**−0.1**	**−0.1**	**0.1**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.1**	**0.2**	**0.11**
6–7 p. m	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	−0.1	−0.2	−0.1	−0.02
8 p. m	**0.1**	**0.0**	**0.0**	**0.1**	**0.2**	**0.3**	**0.1**	**0.1**	**0.1**	**0.2**	**0.0**	**0.0**	**0.10**
7–8 p. m	0.0	0.1	0.1	0.2	−0.1	0.1	−0.1	−0.1	−0.1	0.0	−0.1	−0.2	−0.01
9 p. m	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	**0.0**	**0.1**	**0.0**	**0.1**	**−0.1**	**0.0**	**0.06**
8–9 p. m	0.0	0.1	0.1	0.0	−0.1	−0.1	−0.1	0.0	−0.1	−0.1	−0.1	0.0	−0.04
10 p. m	**0.0**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.0**	**0.1**	**−0.1**	**0.0**	**−0.1**	**−0.2**	**0.01**
9–10 p. m	−0.1	0.0	0.0	0.0	0.0	−0.1	0.0	0.0	−0.1	−0.1	0.0	−0.2	−0.05
11 p. m	**0.0**	**0.0**	**0.1**	**0.0**	**−0.1**	**0.0**	**−0.1**	**0.0**	**−0.1**	**0.0**	**−0.2**	**−0.2**	**−0.05**
10–12 p. m	0.0	−0.1	0.0	−0.1	−0.2	−0.1	−0.1	−0.1	0.0	0.0	−0.1	0.0	−0.06
12 midnight	**−0.1**	**−0.1**	**0.0**	**−0.1**	**−0.2**	**−0.2**	**−0.2**	**−0.1**	**−0.2**	**−0.2**	**−0.2**	**−0.3**	**−0.16**
11–11 midnight	−0.1	−0.1	−0.1	−0.1	−0.1	0.2	−0.1	−0.1	−0.1	−0.2	0.0	−0.1	−0.11
Average	**0.4**	**0.4**	**0.3**	**0.3**	**0.4**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.4**	**0.4**	**0.32**
Average	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.10

HOURS OF THE MOST NOTABLE INCREASE AND DIMINUTION OF THE TENSION OF THE AQUEOUS VAPOR.

In confirmation of that which we have just said relating to the daily variation of the tension of the aqueous vapor in Manila, Table XLIX can be consulted; in which, as we have given the atmospheric pressure, the temperature, and the humidity, we give the difference between each one of the twenty-four hours of the day of each month and the respective monthly averages, adding such additional data of the average range of the increase and decrease of tension of the aqueous vapor corresponding to each hour with respect to the preceding one. In this table it will be easily seen, speaking generally of all the year, that the greatest increase of tension takes place during all the months from 6 to 9 a. m. and the greatest decrease from 11 at night until 4 or 5 in the morning, the changes which this element suffer in the other hours of the day being of very little importance.

Looking, however, at each one of the months, there is also observed a somewhat notable increase in some of the hours of the afternoon during the months of November to April conforming to those which we have above indicated.

NOTABLE DIFFERENCES BETWEEN THE AVERAGE DAILY VARIATION DEDUCED FROM TABLE XLVII AND THAT DEDUCED FROM TABLE XLVIII—IRREGULARITIES IN THE DAILY VARIATION OF THE TENSION OF THE AQUEOUS VAPOR.

Comparing the average values of the daily variation deduced in this paragraph from the difference between the average extremes of the 24 daily observations with those which we have studied in the preceding paragraph, deduced simply from the average difference between the daily maxima and the daily minima of each month, there will be seen a discrepancy notable and otherwise extraordinary. It is certain that from an examination of the proper daily oscillation of the meteorological elements we will find naturally some divergencies in the absolute value of the results obtained by these two methods; but said divergencies are very far from being what they appear in the variation of the tension of the aqueous vapor, which we are now considering. These notable differences are due not so much to the diversity of method employed, with which we have collected these results, as to the fact that the daily variation of this element is far from preserving the regularity which is seen in the others. In confirmation of this it is sufficient to point out, among other facts which we are presently going to analyze, that it is not rare to find the minimum daily tension registered between the hours of 11 a. m. and 5 or 6 p. m., hours when there is the greatest, or, at all events, a very great increase in the temperature of the air, especially so on days that are clear and when the slight humidity of the air is relatively most pronounced. To such a degree is this true that with much frequency it is seen in our monthly bulletins that there is a coincidence, not only in the day but even in the hour, of the monthly minimum tension and humidity, in spite of which, however, the annual average of tension corresponding to the hour of least humidity is, nevertheless, the maximum of the normal hourly averages, but slightly less. This we have already had occasion to remark in paragraph 5, while examining the mean values obtained by means of Table XLII.

CHAPTER V.

PRECIPITATION OF WATER.

INTRODUCTION.

It has been verified that the precipitation of water is one of the elements which influence the climate of any country. For this reason we believe that what we have to say about this matter will be read with pleasure by all who are interested in the climate of the Philippines. With this object in view we have united here all the data which we could obtain from the observatory from its foundation in 1865 until the present year, 1899. We examined closely all the statements and calculations therein contained in order that the result of this study might be entirely satisfactory. We will treat in this chapter of the yearly variation of rain in Manila, of its frequency, its distribution during the different epochs of the year and different hours of the day, of the monthly maximum and minimum precipitation and of the greatest quantity of water collected in one day and in one hour, of the relation of rain to the atmospheric pressure and its distribution in the several points of the archipelago.

VALUE OF MONTHLY AVERAGES.

In Table L we give in millimeters and by months the quantity of water collected in the pluviometers of this observatory during the long period from 1865 to 1898. The curved lines in plate XXIV represent the normal averages of rainfall which, as shown in this table, is the result of observations made in each month of the year. It is shown that the months during which the greatest amount of rain falls in Manila are July and September, during which months the normal averages reach 370 mm. and 379.1 mm.; and the months during which the least rain falls is February, the normal average of which never exceeds 10.5 mm. As will be seen by reference to the engraving, the normal average of rainfall is augmented gradually from February to July, and diminishes gradually from September to February; in August the value of the average decreases until it reaches the medium of the two maximum averages of the whole year.

I.—YEARLY VARIATION OF RAINFALL IN MANILA.

TABLE I.—*Quantity of water collected in the pluviometers in the observatory at Manila for the years 1865 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1865	11.0	38.0	0.0	0.0	90.6	266.2
1866	44.0	0.0	60.0	20.0	106.4	355.0
1867	21.5	18.2	12.8	21.5	169.0	206.0
1868	9.0	0.0	0.0	0.0	75.0	393.7
1869	35.5	11.1	0.0	40.8	129.2	276.9
1870	82.6	24.6	3.4	21.0	194.1	199.2
1871	9.6	6.7	11.2	0.0	12.6	375.7
1872	15.3	10.0	28.2	39.8	89.4	168.6
1873	20.0	12.8	14.0	100.9	59.0	354.3
1874	13.9	5.0	2.2	17.7	37.2	110.3
1875	99.2	28.3	24.2	2.3	0.0	49.4
1876	28.4	3.6	9.4	29.8	185.7	222.1
1877	2.8	0.2	0.2	0.0	200.4	233.9
1878	1.5	7.5	10.8	5.5	76.2	207.2
1879	55.2	39.6	11.3	119.8	103.9	96.5
1880	42.3	11.6	15.6	136.4	21.0	205.5
1881	4.1	0.0	9.2	7.1	174.2	433.0
1882	9.5	28.0	30.7	40.8	131.9	235.1
1883	195.2	15.4	23.0	75.3	123.7	212.9
1884	0.5	0.4	5.5	0.0	96.4	297.8
1885	2.0	0.0	3.0	22.8	1.2	169.5
1886	3.0	16.5	0.0	31.4	107.1	219.9
1887	13.4	4.8	100.2	27.2	256.9	135.7
1888	16.0	0.0	18.8	14.3	28.2	265.4
1889	98.1	10.8	1.8	3.5	0.0	167.7
1890	14.1	15.6	16.4	77.3	69.6	255.5
1891	18.7	1.8	4.1	4.0	97.7	655.5
1892	43.7	17.1	27.1	13.8	76.2	114.2
1893	14.2	5.7	18.0	20.8	184.5	24.8
1894	10.0	3.3	61.9	22.1	108.1	281.3
1895	26.7	1.6	11.4	5.6	246.8	539.5
1896	1.0	7.6	10.6	4.9	168.8	156.6
1897	12.3	0.0	22.4	25.6	36.3	96.0
1898	54.2	10.3	65.6	35.5	167.1	329.6
Average	30.3	10.5	18.7	29.0	106.6	244.4

Year.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	
1865	249.0	219.0	687.9	266.4	95.0	19.5	1,942.6
1866	134.0	302.7	362.5	403.9	137.5	131.0	2,057.0
1867	357.8	340.2	1,469.7	280.1	69.0	13.0	2,978.8
1868	286.0	286.5	462.0	162.4	267.3	2.3	1,943.9
1869	368.8	407.8	446.2	589.7	200.8	42.0	2,548.8
1870	390.1	423.3	273.7	133.8	210.8	46.1	2,002.7
1871	269.6	248.9	351.3	189.1	141.4	7.9	1,624.0
1872	206.6	798.8	257.4	198.0	133.4	32.0	1,977.5
1873	261.7	388.3	146.1	317.8	37.9	1.0	1,713.8
1874	284.4	422.0	115.6	138.2	45.5	15.0	1,207.0
1875	330.2	400.7	486.9	134.2	98.6	32.9	1,686.9
1876	470.1	339.6	520.3	58.2	61.5	61.5	1,990.2
1877	602.0	1,095.6	93.6	239.4	50.1	6.8	2,525.0
1878	239.1	220.5	399.6	99.6	122.4	89.6	1,479.5
1879	143.4	290.7	316.4	147.3	397.8	5.0	1,726.9
1880	809.8	499.8	349.6	172.8	105.7	36.4	2,406.5
1881	486.7	440.7	255.7	155.5	64.9	91.2	2,122.3
1882	573.6	306.3	327.5	320.3	177.4	104.9	2,286.0
1883	754.6	256.5	353.4	162.0	72.5	3.2	2,247.7
1884	721.0	327.5	194.2	47.5	149.1	61.7	1,901.6
1885	313.9	170.7	50.8	111.6	57.5	3.5	906.5
1886	225.9	248.4	233.1	363.5	63.5	89.3	1,601.6
1887	378.7	142.8	738.0	210.9	141.9	117.2	2,267.7
1888	680.6	355.2	138.1	200.2	53.4	36.9	1,807.1
1889	292.9	339.0	117.5	198.8	152.6	346.9	1,732.6
1890	498.8	130.8	536.7	224.9	209.9	45.4	2,095.0
1891	642.7	276.1	477.8	39.5	306.6	59.2	2,583.7
1892	231.0	151.0	377.2	77.7	100.7	52.9	1,282.6
1893	234.2	276.8	475.1	83.8	94.2	9.3	1,441.4
1894	209.9	189.5	399.2	221.6	59.9	108.6	1,678.4
1895	178.6	349.4	463.8	78.3	167.6	15.4	2,084.7
1896	221.8	650.2	424.6	109.2	29.8	0.2	1,785.3
1897	245.7	263.6	263.2	121.7	73.9	112.8	1,303.5
1898	288,1	414.3	325.1	245.2	277.6	14.1	2,226.7
Average	370.0	352.2	379.1	191.4	130.2	54.2	1,916.6

GENERAL CAUSES OF RAINFALLS IN MANILA.

What we have just said should be compared with what we will have to say in the second paragraph of the eighth chapter. The engraving which we will present in the eighth chapter should be considered in comparison with the engraving which we are now studying. From the coincidence between the hurricanes and their monthly distribution in the extreme Orient and the yearly variations of rainfall in Manila, it may be deduced with reasonable probability that they are controlled in a large measure by the influence of atmospheric perturbations.

As we touch upon this point we will indicate, in passing, the three causes which we believe to be nearly the only ones of the precipitation of water as observed in Manila during the course of the year.

The first and principal cause is the atmospheric perturbation, including, under this head, not only the true hurricanes, or cyclones, but also the other centers or large areas of low pressure of which we will speak shortly in the first paragraph of the eighth chapter.

The second cause of rainfalls in Manila is the tornado, local tempest accompanied by great thunder and lightning which frequently continues from May to October, both months inclusive, and occasionally in April and November, but is very rare from December to March. These rains are distinguished from the preceding ones in that while they are sometimes fierce and come in torrents, still they are usually of short duration, as is also the duration of the phenomenon which produces them. They rarely occur in the morning, but are frequent in the afternoon and evening, continuing during the night. Sometimes these rains are prolonged for several days, during which time the cyclonic centers which cause the same exist.

Finally, we cite as the third cause of rain in Manila the influence of the center of maximum pressure which in the months of December and February is found to be situated in Siberia toward the north-northwest of Luzon, frequently extending its ramifications to Mongolio, north of China, and the sea of Japan; the current of the first quadrant influenced by the maximum pressure causes great and frequent condensations which, in the months referred to, are produced on the Oriental coast of the archipelago, being at times also abundant and extraordinary in their force and reaching to the Occidental coasts.

CAUSES OF RAINFALL IN MANILA DURING THE DIFFERENT MONTHS OF THE YEAR.

With reference particularly to the different months of the year, we can say that the rainfalls observed in Manila during the months of December and January are usually the result of high pressure of the cyclonic centers and of large areas of low pressure. The rains of February are usually produced by high pressure from the north or areas of low pressure in the region of the archipelago. The rains of March, April, and May are mainly caused by electric tempests, as is especially true of those occurring during April, while those of May are the result of the influence of cyclonic centers. Finally, the principal cause of rain during June and November is the typhoon which frequently occurs during these months and the large area of low pressure which extends to a higher parallel than those which occur during

December, January, and February. To this class of rainfalls should be assigned the rains that occur during the months of June and July, notwithstanding the fact that the second cause of these disturbances which we have before mentioned—the tornadoes and electric tempests—abound during this season of the year, especially from May to October.

YEARLY AVERAGE—TOTAL AMOUNT OF WATER COLLECTED IN MANILA DURING EACH OF THE LAST THIRTY-FOUR YEARS.

The yearly average of rainfall deduced from observations covering a period of thirty-four years, which is embraced in Table L, is 1,916.6 mm. It is a fact that frequently there is a vast difference in the amount of rain that falls from one year to another in Manila, as can be seen by reference to Table L. During the period which we are studying, the maximum of rain for one year is shown to have been during 1867, during which time the observations made, by use of the pluviometer in the observatory, show an average of 2,978.8 mm.; in 1885, an excessively dry year, there did not fall in Manila more tnan 906.5 mm. of water. This shows that the difference between the maximum and minimum rainfall yearly for this season is 2,072.3 mm., a larger quantity than in any other yearly average.

In Engraving XXV we graphically represent the total amount of water collected in Manila during the last thirty-four years.

II.—DAYS OF RAIN IN MANILA.

Table LI contains, by months and by years, the number of rainy days in Manila from 1866 to 1898.

TABLE LI.—*Days of rain in Manila during the years from 1866 to 1898.*

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1866	5	0	1	1	9	15	16	18	22	23	10	14	134
1867	6	2	4	2	10	9	14	23	26	15	10	4	125
1868	4	0	0	0	5	19	20	17	20	15	8	1	109
1869	1	2	0	2	11	14	19	16	15	20	8	8	116
1870	11	7	1	5	11	14	19	21	20	13	15	4	141
1871	4	3	1	0	4	18	15	16	18	13	11	5	108
1872	7	10	3	4	9	17	13	19	17	18	15	5	137
1873	8	4	2	9	2	16	20	23	15	17	5	3	124
1874	4	3	1	4	5	13	16	21	10	13	7	4	101
1875	8	7	4	1	0	6	21	23	26	21	15	7	139
1876	5	2	3	5	17	19	27	25	22	10	8	11	154
1877	6	1	2	0	10	19	24	26	13	20	14	5	140
1878	4	3	3	4	8	15	23	16	21	13	17	14	141
1879	10	5	3	9	6	13	12	18	18	14	19	3	130
1880	7	2	6	6	7	19	23	18	20	15	8	11	142
1881	6	0	5	1	4	13	30	17	18	12	14	8	128
1882	2	5	6	4	7	15	26	15	22	19	10	13	144
1883	5	5	3	9	10	19	19	18	27	16	10	1	142
1884	1	1	1	0	10	21	27	22	20	15	12	12	142
1885	1	0	1	4	1	11	17	17	11	14	10	2	89
1886	3	2	0	3	10	18	20	19	21	21	16	12	145
1887	5	3	7	3	20	19	22	19	29	12	13	14	166
1888	1	0	4	2	8	19	29	19	14	15	13	6	130
1889	9	1	2	2	0	13	20	25	22	18	13	13	138
1890	7	5	2	7	13	16	17	13	25	21	7	7	140
1891	7	2	3	1	5	18	23	26	15	9	12	13	134
1892	6	2	5	6	9	17	25	20	22	11	14	9	146
1893	3	3	2	5	16	14	17	22	26	15	11	8	142
1894	4	2	2	2	14	18	21	22	20	15	14	8	142
1895	5	2	4	2	19	14	22	22	23	13	10	8	144
1896	2	2	3	2	17	12	19	28	22	15	4	2	128
1897	3	0	2	5	10	11	18	23	24	22	10	17	145
1898	9	5	13	11	13	22	26	22	22	24	22	9	198
Average	5.1	2.8	3.0	3.7	9.1	15.6	20.6	20.3	20.2	16.0	11.7	7.9	135.9

WHAT DO WE UNDERSTAND BY RAINY DAYS?

We understand by the words "rainy days" all those days during which enough rain has fallen to be appreciated, or measured, by our apparatus; and in this case days of passing showers are not registered, and therefore have not been taken into account in forming this table.[1]

DISTRIBUTION OF THE DAYS OF RAIN DURING THE DIFFERENT MONTHS OF THE YEAR.

The maximum of days of rain is observed during July, August, and September, and the minimum in February and March. From the maximum rainfall observed in the first-named three months until the minimum in the last-named two months the number of days gradually diminishes; and the number of rainy days increases gradually from the minimum in February to the maximum in July.

YEARLY AVERAGE DAYS OF RAIN—TOTAL OF DAYS OF RAIN IN THE LAST THIRTY-THREE YEARS.

The yearly average of rainy days is 135.9. The year 1898 shows a total of 198 days of rain, while in 1885 there were only 89 days of rain. The difference in these two figures, embracing the yearly maximum and minimum, is 109. Subtracting from these two years the maximum difference which is observed between the two totals of the rainy daysof all the rest, the average would not exceed sixty-five days.

III.—DISTRIBUTION OF RAINFALL IN MANILA DURING THE DIFFERENT SEASONS OF THE YEAR.

DRY SEASON AND HUMID OR RAINY SEASON.

The writers who generally treat of the climate of the intertropical regions usually take much care to distinguish the two season, the dry season, which lasts from November to May, inclusive (seven months), and the humid or rainy season, also called the epoch of rain, which continues during the other five months, from June to October, both inclusive.

THE DIVISION OF THE YEAR INTO TWO SEASONS CAN NOT BE GENERALLY APPLIED TO THE WHOLE ARCHIPELAGO.

In considering the climate of the Philippines it must be taken into account from the start that this division can only be applied to the interior, and principally to the occidental coasts of the archipelago, but not in any manner whatever to the oriental regions, as we shall see more fully below when we shall consider the yearly distribution of rain in the different points of the islands.

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[1] In the bulletins of this observatory, probably on account of the change in the personnel which has taken place, we have found that in some years there was included in the total number of rainy days the days of simple showers, and in other years this was not the case; so that if we have in some way modified some of these statements it has been with the object of having them uniform, in order that the true monthly averages might then be deduced.

IN WHAT SENSE DO WE APPLY THESE TWO SEASONS TO MANILA?—OUTLINE OF DISTRIBUTION OF RAIN IN MANILA DURING JUNE–SEPTEMBER, 1899.

If we include the capital only, which is found on the occidental coast of Luzon, we shall have no difficulty whatever in applying the two seasons to this territory, especially when it is understood that the epochs of rain are not so called because of lack of interruption in the rain in the whole five months, but because the total quantity of water which is precipitated in that time is always greater than the amount collected in the other seven months of the year. We say this because the so-called rainy months, June–October, are not so produced by a constant cause, but, for instance, by a monsoon, and, as we have already indicated above, are subject to the influence of the tornadoes and atmospheric perturbations, which are never a constant cause, but rather vary much in character and force, and often have long periods of interruptions. For this reason it is not a rare occurrence, as has already been noted in the case of September of 1899, for ten, fifteen, or even more days to pass without rain, or, at best, with showers of but little importance. Confirmatory of what we have just said, we believe it will not fail to be of interest to explain here the manner in which the rainfall in Manila has been distributed during the months of June, July, August, and September. For this reason we have made the attached outline, in which, besides the quantity of water collected daily in the observatory, we have added the hours of sun and some other observations which will enable one to better understand the nature and course of the rainfall cited.

Outline of the distribution of rain in Manila during the months of June to September, 1899.

JUNE.

Day.	Total of rain in mm.	Hours of sun.	Observations.
1	0.0	7.45	
2	8.5	7.15	At 2.35 p. m. rain with tornado for scarce half an hour.
3	0.0	9.35	
4	2.3	6.15	At 11.40 a. m. rain of short duration.
5	7.6	10.30	From 8.45 p. m. to 12 m. rain with intervals of tornadoes.
6	3.1	9.40	Passing rains at 1 a. m., 10, and 11 p. m.
7	5.1	0.45	Brief rain at intervals from 10 a. m. to 7 p. m.
8	0.0	8.45	
9	0.0	10.00	
10	0.0	8.00	
11	7.0	7.05	Rain of regular duration between 8 and 10 p. m.
12	0.0	7.40	
13	0.0	8.00	
14	43.5	5.40	Rain with tornadoes between 5 and 9 p. m.
15	1.0	8.05	Passing rain between 7 and 8 p. m.
16	1.0	8.40	Passing rain between 1 and 2 a. m.
17	0.0	9.00	
18	0.0	6.00	
19	0.0	10.05	
20	2.5	5.10	Passing rain between 4 and 9 p. m.
21	1.1	5.00	Rain and passing showers between 2 and 5 p. m.
22	2.5	1.35	Rain with tornadoes at 7.13 p. m.
23	1.2	5.25	Passing rain from 4 to 5 a. m.
24	8.2	5.55	Brief rain at intervals, with tornadoes between 2 and 7 a. m.
25	6.5	7.30	Passing rains at intervals 4.40 to 7 p. m.
26	0.5	6.10	Showers at 3 p. m.
27	0.7	4.55	Rain with tornadoes at 7 p. m.
28	105.2	0.00	Raining the whole day.
29	8.8	5.30	Rain at intervals from 4 to 5 a. m. and 1 to 3 p. m.
30	1.0	0.00	Passing rains from 7 to 8 a. m. and between 4 and 6 p. m.
			Total days of rain 20
			Total days exempt from rain and generally fair 10
			Days of rain of much and regular duration 7
			Days of passing rains of short duration and generally 5, 6, or 7 hours of sun. 13

Outline of the distribution of rain in Manila during the months of June to September, 1899—Continued.

JULY.

Day.	Total of rain in mm.	Hours of sun.	Observations.
1	0.0	4.30	
2	11.8	7.15	Passing rains at 9.12 a. m., 12 m., and 2.35 p. m.
3	0.0	6.30	
4	0.6	0.05	Passing rains from 10 a. m. to 3 p. m.
5	2.9	4.30	Passing rains from 10 to 12 p. m.
6	4.4	1.00	Passing rains from 1 to 8 a. m.
7	4.2	5.30	In afternoon and night some short, passing rains.
8	19.0	3.55	Rain of regular duration in different hours of the day.
9	209.8	0.00	Raining the whole day.
10	158.7	0.00	Do.
11	54.7	1.10	From 0 to 11 a. m.
12	3.5	2.45	From 3 to 4 a. m. passing rain.
13	0.4	4.55	From 7 to 8 p. m. very short passing rains.
14	2.6	1.00	From 8 to 10 a. m. and 7 to 8 p. m. passing rains.
15	6.3	8.00	Passing rain in the early morning.
16	0.0	5.15	
17	3.2	4.05	Passing rain from 0 to 1 a. m. and 3.35 p. m.
18	169.3	0.00	Raining the whole day.
19	253.5	0.00	Do.
20	148.8	0.00	Do.
21	29.1	3.30	Raining the whole morning and from 9 to 10 p. m.
22	0.0	10.30	
23	0.0	10.30	
24	0.0	11.20	
25	8.2	6.30	From 5 to 8 p. m. slight rain.
26	25.4	4.30	From 1.15 p. m. to 4.15 and 9 p. m. rains at intervals.
27	8.5	5.40	From 2 to 9 p. m. rains with tornadoes at intervals.
28	4.0	6.45	From 7 to 8 a. m. and from 11 to 12 p. m. short rains.
29	35.1	10.40	From 0 to 4 a. m. rains at intervals.
30	7.4	7.00	At 7.15 a. m. passing rains.
31	19.5	8.30	At 10.15 p. m. passing rains.
			Total days of rain 25
			Total days without rain 6
			Days of rain of long and regular duration 13
			Days of short, passing rains 12

AUGUST.

1	16.0	9.50	Passing rain at 8.10 p. m.
2	6.3	3.40	Slight rains from 8 to 11 p. m.
3	0.0	4.55	Passing rains from 5.15 to 7 p. m.
4	4.2	2.00	
5	14.2	1.05	Passing rain, with tornadoes, at 6 a. m. and between 3 and 11 p. m.
6	15.6	1.30	Passing rain from 6 a. m. to 2 p. m.
7	6.5	0.30	Passing rain from 0 to 1 a. m. and at 7 a. m. and 6.52 p. m.
8	2.2	11.00	Passing rain from 0 to 2 a. m. and 4 to 5 a. m.
9	0.0	9.10	
10	2.1	8.05	Short passing rain from 0.50 p. m. to 3.30 p. m.
11	12.0	1.20	Slight rains at 5 a. m. and between 1 and 6 p. m.
12	0.6	8.10	Passing rain from 0 to 1 a. m.
13	2.1	9.00	Passing rain in the early morning.
14	5.3	6.10	Passing rain early in the morning and in afternoon.
15	6.7	6.40	Passing rain from 8 p. m. to 12 midnight.
16	11.4	7.30	Passing rain, with tornadoes, from 4 to 7.10 p. m.
17	7.2	3.30	Passing rain from 2.43 to 4 p. m.
18	15.3	0.00	Slight rains between 4 and 9 a. m. and 4 to 6 p. m.
19	68.1	1.00	Frequent rains from 2 p. m. to 12 midnight.
20	0.0	6.45	
21	12.2	2.45	Several slight rains in afternoon and night.
22	58.5	0.00	Raining the whole day.
23	28.0	0.07	Do.
24	1.3	1.05	Slight rains from 1 to 2 a. m. and 8 to 11 a. m.
25	0.0	8.35	
26	25.0	0.00	Slight rains between 2 a. m. to 3 p. m.
27	11.1	3.20	Slight rains from 1 to 2 a. m. and 6 to 11 p. m.
28	0.5	8.00	Passing rain from 11 to 12 midnight.
29	6.9	0.00	Frequent rains from 0 a. m. to 1 p. m. and 6 p. m.
30	0.0	5.55	
31	0.0	9.30	
			Total days of rain 25
			Total days without rain 6
			Days of rain of long and regular duration 13
			Days of short passing rains.......... 12

Outline of the distribution of rain in Manila during the months of June to September, 1899—Continued.

SEPTEMBER.

Day.	Total of rain in mm.	Hours of sun.	Observations.
1	0.0	3.00	
2	0.0	10.40	
3	15.2	1.40	Rains at intervals from 11 a. m. to 9 p. m.
4	3.9	0.00	Passing rains 0 to 10 a. m.
5	4.6	4.30	Passing rains, with tornado, from 10 a. m. to 12 m.
6	19.3	1.50	Passing rains, with tornado, from 11.13 to 1 p. m.
7	0.8	9.10	Passing rains from 4 to 5 p. m.
8	0.0	11.30	
9	0.0	11.40	
10	1.0	10.45	Passing rains from 4 to 5 a. m.
11	0.0	9.55	
12	12.2	7.20	Passing rains, with tornadoes, from 2 to 3 p. m. and 7 to 8 p. m.
13	1.4	7.20	Passing rains, with tornadoes, between 2 and 3 p. m.
14	0.0	6.25	
15	0.0	5.20	
16	4.6	1.20	Passing rains at 8.44 p. m.
17	47.5	4.10	Frequent rains, with tornadoes, between 12 m. and 7 p. m.
18	12.7	0.35	Frequent rains between 7 p. m. to 12 p. m.
19	64.7	0.00	Raining the whole day.
20	180.8	0.00	Do.
21	8.5	0.35	Slight rains between 1 and 3 a. m. and 10 a. m. to 7 p. m
22	0.6	0.35	Passing rains from 4 to 5 a. m.
23	0.0	6.55	
24	7.2	6.00	Passing rains from 5.23 to 8 p. m.
25	0.0	9.30	
26	0.0	9.15	
27	0.0	10.05	
28	0.0	11.20	
29	0.0	9.45	
30	0.0	7.40	
			Total days of rain 16
			Total days without rain 14
			Days of rain of long and regular duration 7
			Days of short passing rains 9

This outline gives the evident result that in these four months of rainy season of the present year (1899) there were only 7 days in June, 13 in July, 13 in August, and 7 in September, a total of 40 days, which may be properly called rainy days. The other days may be considered absolutely exempt from rain, or may have only passing showers, and they could very well figure as days not improperly called the dry season, in the months of November to May.

NOTABLE DIFFERENCE IN THE QUANTITY OF RAIN IN THE TWO SEASONS.

Accepting the sense in which we take the words "dry season" and "humid" or "rainy season," we give in Table LII the total quantity of water and the days of rain corresponding to each one of these two epochs of the year in the period from 1865 to 1898. In this table it will be seen from the beginning that a great difference exists between the two seasons, resulting in an average percentage of rain of 20 for the dry season and 80 for the humid or rainy season.

PLATE XXIV.

ANNUAL VARIATION OF THE RAIN AT MANILA

1865-1898

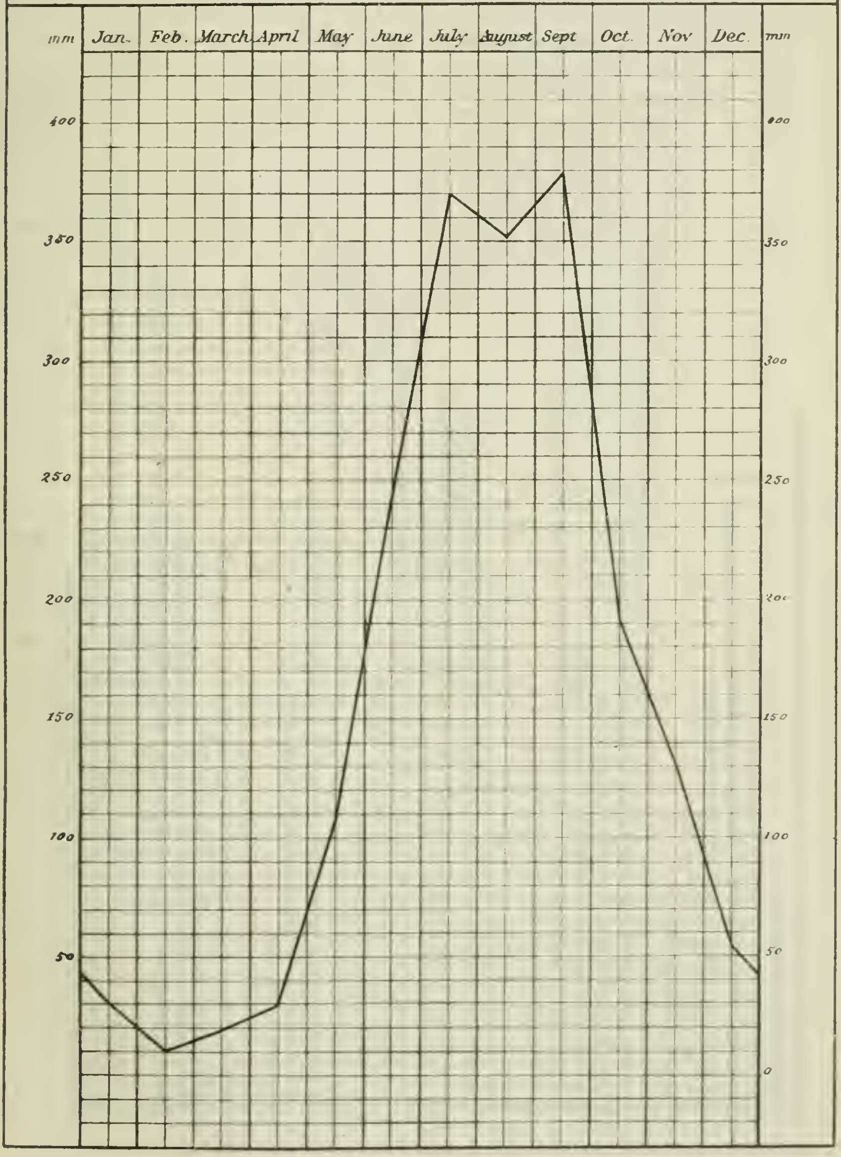


PLATE XXV.

RAIN AT MANILA

Annual Quantity in millimeters, from 1865 to 1898

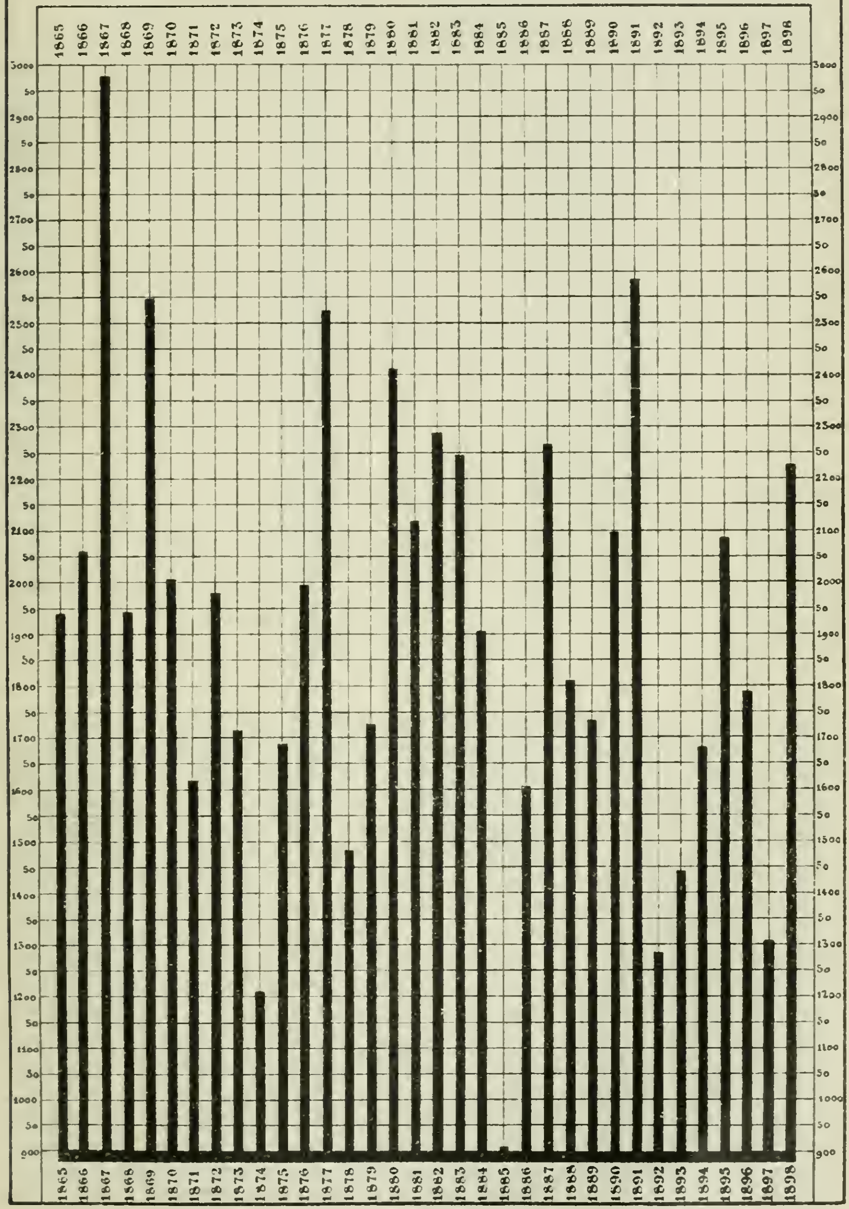


TABLE LII.—*Total rainfall and days of rain in the dry and rainy season during period from 1865 to 1898.*

Years.	Dry season.				Rainy season.			
	Rain.		Days of rain.		Rain.		Days of rain.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
1865	254.1	13	....	....	1,688.5	87	....	....
1866	498.9	24	40	30	1,558.1	76	94	70
1867	325.0	11	38	30	2,653.8	89	87	70
1868	353.3	18	18	17	1,590.6	82	91	83
1869	459.4	18	32	28	2,089.4	82	84	72
1870	582.6	29	54	38	1,420.1	71	87	62
1871	189.4	12	28	26	1,431.6	88	80	74
1872	348.1	18	53	39	1,629.4	82	84	61
1873	245.6	14	33	27	1,468.2	86	91	73
1874	136.5	11	28	28	1,070.5	89	73	72
1875	285.5	17	42	30	1,401.4	83	97	70
1876	379.9	19	51	33	1,610.3	81	103	67
1877	260.5	10	38	27	2,264.5	90	102	73
1878	313.5	21	53	38	1,166.0	79	88	62
1879	732.6	42	55	42	994.3	58	75	58
1880	369.0	15	47	33	2,037.5	85	95	67
1881	350.7	17	38	30	1,771.6	83	90	70
1882	523.2	23	47	33	1,762.8	77	97	67
1883	508.3	23	43	30	1,739.4	77	99	70
1884	313.6	16	37	26	1,588.0	84	105	74
1885	90.0	10	19	21	816.5	90	70	79
1886	310.8	19	46	32	1,290.8	81	98	68
1887	661.6	29	65	39	1,606.1	71	101	61
1888	167.6	9	34	26	1,639.5	91	96	74
1889	616.7	36	40	29	1,115.9	64	99	71
1890	448.3	21	48	34	1,646.7	79	92	66
1891	492.1	19	43	32	2,091.6	81	91	68
1892	331.5	26	51	35	951.1	74	95	65
1893	346.7	24	48	34	1,094.7	76	94	66
1894	373.9	22	46	32	1,304.5	78	96	68
1895	475.1	23	50	35	1,609.6	77	94	65
1896	222.9	12	32	25	1,562.4	88	96	75
1897	313.3	24	47	32	990.2	76	98	68
1898	624.4	28	82	41	1,602.3	72	116	59
Averages	379.5	20	43	31	1,537.1	80	93	69

It may be noted that in these last we have included five months and in the first we embrace seven months, for it is easily seen that if divided the year into equal parts the contrast would be still greater. Notwithstanding we would like to admit this division, even though unequal in results, since it appears to be the one adopted by most writers upon this subject, it is not the proper one, although it has not failed some who have not included in the epoch of rain part at least of the month of November, and some others who, excluding this month, has counted as rainy days the month of May. If the normal averages are closely examined in each month, it will be observed that the leaps made in the average of April to the average of May, and those of November to December, are very brusque, so that we doubt at the start, with cause, if we had not best count, at least in part, as included in the season of rain the two months of May and November. For this reason we take the total of water collected in these months during the last fifteen years and divide the months into halves, when we find that the average of the first and second half of both months can be easily ascertained. But as the result of these averages would matter very little to us, we maintain that there is no reasonable motive for including in the rainy season the second half of May or the first half of November, as it is our intention to exclude the other two.

CONTRAST BETWEEN THE RAIN IN THE THREE DRIEST AND THE THREE MOST RAINY MONTHS OF THE YEAR.

For this reason we have followed the division of the year as above indicated, but to make it more plain, and to show the extraordinary difference which exists between the epoch of rain and the months less characteristic also of the dry season, we have formed the Table LIII, in which we have united on one side the total of rain collected in Manila in the three driest months of the year, February, March, and April, and on the other side the total by itself of the other three most rainy months, July, August, and September, adding later the difference between the two totals. As shown by this table the average of rain during the first period, February to April, is 52.2 mm., and the average of the second period, July to September, is 1,101.3 mm., while the difference between the two averages is 1,043.1 mm.

Table LIII.—*Difference between the total rainfall of the dryest months of the year and the three most rainy months during period from 1865 to 1898.*

Year.	From February to April.	From July to September.	Difference.
1865	38.0	1,155.9	1,117.9
1866	80.0	799.2	719.2
1867	52.5	2,167.7	2,115.2
1868	0.0	1,034.5	1,034.5
1869	51.9	1,222.8	1,170.9
1870	49.0	1,087.1	1,038.1
1871	17.9	869.8	851.9
1872	78.0	1,262.8	1,184.8
1873	127.7	796.1	668.4
1874	24.9	822.0	797.1
1875	54.8	1,217.8	1,163.0
1876	42.8	1,330.0	1,287.2
1877	0.4	1,791.2	1,790.8
1878	23.8	859.2	835.4
1879	170.7	750.5	579.8
1880	163.6	1,659.2	1,495.6
1881	16.3	1,183.1	1,166.8
1882	99.5	1,207.4	1,107.9
1883	113.7	1,364.5	1,250.8
1884	5.9	1,242.7	1,236.8
1885	25.8	535.4	509.6
1886	47.9	707.4	659.5
1887	132.2	1,259.5	1,127.3
1888	33.1	1,173.9	1,140.8
1889	19.1	749.4	730.3
1890	109.3	1,166.3	1,057.0
1891	9.9	1,396.6	1,386.7
1892	58.0	759.2	701.2
1893	44.5	986.1	941.6
1894	87.3	798.6	711.3
1895	18.6	991.8	973.2
1896	23.1	1,296.6	1,273.5
1897	48.0	772.5	724.5
1898	111.4	1,027.5	916.1
Average	58.2	1,101.3	1,043.1

IV.—MONTHLY AND YEARLY MAXIMA AND MINIMA.

Tables LIV and LV contain, by months, the absolute extremes of quantities of water precipitated (1865 to 1898), and the days of rain (1866 to 1898), the difference between both extremes, and the normal values of each month with which they are compared:

TABLE LIV.—*Absolute maxima and minima during the period from 1865 to 1898.*

Month.	Normal.	Absolute maximum.		Absolute minimum.		Difference.
January	30.3	195.2	(1883)	0.5	(1884)	194.7
February	10.5	39.6	(1879)	0.0	1866 1868 1881 1885 1888 1897	39.6
March	18.7	100.2	(1887)	0.0	18 5 1868 1869 1886	100.2
April	29.0	136.4	(1880)	0.0	1865 1868 1871 1884	136.4
May	106.6	256.9	(1887)	0.0	1875 1889	256.9
June	244.4	655.5	(1891)	24.8	(1893)	630.7
July	370.0	809.8	(1880)	134.0	(1866)	675.8
August	352.2	1,095.6	(1877)	130.8	(1890)	964.8
September	379.1	1,469.7	(1867)	50.8	(1885)	1,418.9
October	191.4	589.7	(1869)	39.5	(1891)	550.2
November	130.2	397.8	(1879)	29.8	(1896)	368.0
December	54.2	346.9	(1889)	0.2	(1896)	346.7

TABLE LV.—*Absolute maxima and minima of rain during the period from 1866 to 1898.*

Month.	Normal.	Absolute maximum.		Absolute minimum.		Difference.
January	5.1	11	(1870)	1	1869 1884 1885 1888	10
February	2.8	10	(1872)	0	1866 1868 1881 1885 1888 1897	10
March	3.0	13	(1898)	0	1868 1869 1886	13
April	3.7	11	(1898)	0	1868 1871 1877 1884	11
May	9.1	20	(1887)	0	1875 1889	20
June	15.6	22	(1898)	6	(1875)	16
July	20.6	30	(1881)	12	(1879)	18
August	20.3	28	(1896)	13	(1890)	15
September	20.2	29	(1887)	10	(1874)	19
October	16.0	24	(1898)	9	(1891)	15
November	11.7	22	(1898)	4	(1896)	18
December	7.9	17	(1897)	1	1868 1883	16

DIFFERENCE BETWEEN THE ABSOLUTE MAXIMA AND MINIMA OF THE MONTHLY AVERAGES.

Looking only at Table LIV we will be convinced of how much the quantity of water which falls in any one month sometimes separates itself from the average of the same month, and it is enough to state that the difference between the two extremes, maximum and minimum, of each month always shows a greater result than the monthly average.

Something similar can be said of the difference between the maximum and minimum of the days of rain from November to June, which is greater than the normal average of said months, is a little less than normal in August, and still less than the normal in July, September, and October.

MONTHS OF MOST ABUNDANT RAINS IN THE PERIOD BETWEEN 1865–1898.

The most heavy and abundant rainfalls which, until up to date, have been registered in this observatory, cover the month of September, 1867, in which there fell, in Manila, 1,469.7 mm. of water. On the other hand, another September, in 1885, only 50.8 mm. of water fell in Manila. After September, 1867, the most rainy month or months which have been registered in our pluviometer, during which the greatest quantity of water fell, was last July, 1899, when a total of 1,011.9 mm. of water fell, which quantity is not included in Table LIV, because this table only covers the period including 1898. As third instance may figure the month of August, 1877, in which 1,095.6 mm. of water were collected.

MONTHS DURING WHICH THERE WAS NO PRECIPITATION OF WATER.

Concerning the absolute maximums, it will be seen that there have passed as many as six Februarys absolutely without rain, five Aprils, four Marchs, and two Mays.

DISTRIBUTION OF THE YEARLY MAXIMA AND MINIMA DURING THE DIFFERENT MONTHS OF THE YEAR.

The frequency with which the yearly maximum and minimum quantities of water and the days of rain occur can be seen in the following table:

Rainfall.		Days of rain.	
Maximum.	Minimum.	Maximum.	Minimum.
June 3	....	....	....
July 7	Jan. 3	June 1	Jan. 2
Aug. 8	Feb. 15	July 11	Feb. 16
Sept. 11	Mar. 7	Aug. 10	Mar. 12
Oct. 3	Apr. 6	Sept. 11	Apr. 10
Nov. 1	May 2	Oct. 3	May 3
Dec. 1	Dec. 4	Nov. 1	Dec. 3

The greatest frequency of the yearly minima corresponds to the month of February, as has been observed. On the other hand, the frequency of maxima is in the month of September. These maxima and minima decrease in the following order: August, July, June, October, November, and December. The fact that the greatest maximum was obtained once in November (1879) and once in the month of December (1889) must be regarded as extraordinary.

TABLE LVI.—*Daily maximum rainfall during period from 1865 to 1899.*

Year.	January.		February.		March.		April.		May.		June.	
	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.
1865	6.0	......	38.0	......	0	0	0	0	28.0	......	69.0	......
1866	12.0	12	0	0	60.0	18	20.0	24	55.0	9	92.0	24
1867	13.0	22	14.0	27	7.2	30	19.0	11	39.0	30	63.0	26
1868	3.0	25	0	0	0	0	0	0	36.0	17	80.5	18
1869	35.5	6	8.1	20	0	0	30.0	26	30.8	8	102.8	23
1870	30.0	25	13.0	9	3.4	4	13.2	23	101.8	12	42.4	11
1871	4.4	9	2.5	15	11.2	9	0	0	3.6	22	80.1	24
1872	8.0	24	4.0	12	17.5	27	15.2	2	32.0	22	32.2	13
1873	9.2	9	4.5	23	10.0	31	43.8	13	51.0	29	74.3	25
1874	11.7	8	4.3	14	2.2	13	12.2	28	12.0	27	31.1	22
1875	27.1	4	14.1	18	8.1	31	2.3	3	0	0	17.7	24
1876	12.6	10	3.1	12	7.3	28	12.9	14	30.1	21	28.8	9
1877	1.9	30	0.2	26	0.1	2 5	0	0	53.6	28	111.4	21
1878	0.8	13	4.6	7	5.8	2	4.3	5	45.0	20	44.2	29
1879	15.3	11	34.9	2	5.6	9	30.0	16 24	51.5	31	30.4	1
1880	20.3	5	11.1	24	7.5	22	42.0	25	11.1	22	39.4	3
1881	1.6	13	0	0	3.8	21	7.1	25	166.8	24	139.3	29
1882	5.9	1	15.0	1	15.0	14	19.8	10	56.0	5	67.3	29
1883	186.1	1	9.7	11	20.0	29	24.0	25	29.5	26	88.0	3
1884	0.5	29	0.4	16	5.5	9	0	0	21.2	25	41.0	15
1885	2.0	9	0	0	3.0	17	18.0	22	1.2	4	52.8	29
1886	1.5	16	14.0	11	0	0	29.4	29	32.5	13	45.4	16
1887	5.2	16	2.8	12	24.2	6	10.8	3	45.6	25	26.2	21
1888	16.0	24	0	0	10.8	29	14.0	20	7.5	18	50.4	17
1889	51.0	29	10.8	19	3.0	1	2.5	23	0	0	49.4	30
1890	5.0	25	10.5	7	15.4	12	18.8	5	12.4	25	34.1	15
1891	9.5	14	1.1	8	3.3	10	4.0	29	56.2	29	252.7	15
1892	39.1	21	17.0	29	12.2	23	5.9	4	64.0	21	18.1	11
1893	7.1	8	2.5	11	13.3	1	13.0	14	62.5	16	6.1	21
1894	6.8	1	2.5	5	52.5	9	21.7	30	28.0	25	93.6	28
1895	19.7	3	1.4	7	9.6	8	4.0	29	71.3	13	143.4	24
1896	0.6	1	5.6	13	8.0	2	4.2	27	36.4	17	58.3	6
1897	7.1	22	0	0	22.2	16	10.7	30	11.5	28	33.0	16
1898	21.2	2	4.2	24	24.4	11	15.0	13	49.9	31	80.1	16
1899	22.4	15	1.5	12 13	7.5	15	25.7	30	12.2	16	105.2	28

Year.	July.		August.		September.		October.		November.		December.	
	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.	Millimeters.	Day.
1865	44.5	......	36.0	......	114.0	......	94.0	3	37.5	9	8.5	16
1866	21.5	21	79.0	28	55.0	18	61.0	19	55.0	30	65.5	14
1867	145.0	12	59.0	2	336.0	24	172.0	7	24.0	16	5.0	7
1868	50.0	17	40.0	30	82.0	9	32.5	16	139.1	22	2.0	21
1869	101.8	19	107.6	2	128.0	26	94.8	1	86.0	21	10.0	17 24
1870	71.0	9	72.6	21	46.9	13	29.7	27	40.0	5	25.2	9
1871	45.0	23	76.0	3	56.7	29	88.1	16	80.1	3	5.0	8
1872	67.3	22	226.5	2	42.0	3	87.5	13	52.7	5	20.0	10
1873	48.7	8	69.6	31	23.8	17	85.0	1	14.7	2	0.5	25
1874	63.8	3	124.8	30	37.2	28	26.1	2	18.5	1	5.0	9 12
1875	79.8	12	69.1	22	60.4	28	27.1	27	15.6	20	13.2	3
1876	104.5	17	95.5	8	117.8	13	13.2	17	25.2	4	32.6	18
1877	91.2	13	192.7	15	32.2	15	60.0	14	19.1	5	2.2	3
1878	128.8	30	84.0	17	74.2	23	23.3	30	21.0	23	26.0	23
1879	59.2	31	49.3	27	162.3	20	74.8	8	102.6	20	2.6	15
1880	290.1	30	111.6	4	213.1	15	48.0	12	68.8	8	8.5	2
1881	96.0	7	118.8	20	61.3	16	20.8	13	15.3	3	37.3	12
1882	176.8	28	86.4	8	50.5	22	165.2	20	67.2	5	26.2	19
1883	156.9	29	46.0	2 18	5.0	5	34.5	30	14.7	18	3.2	12
1884	179.5	21	57.8	8	50.9	12	11.2	2	98.7	18	17.7	2
1885	74.3	24	41.0	11	11.4	5	24.0	6	18.9	7	3.0	3
1886	38.0	12	45.9	25	48.8	18	76.0	10	16.9	5	34.7	19
1887	115.7	21	41.6	17	164.8	19	118.6	5	64.2	26	35.4	5
1888	109.2	23	107.4	16	47.0	17	31.5	12	14.0	16	21.1	5
1889	95.5	15	63.0	6	40.2	10	76.0	19	63.3	3	90.0	1
1890	189.1	16	37.6	25	83.0	29	29.0	14	153.8	11	20.3	22
1891	139.4	26	89.6	22	115.8	15	15.5	9	180.6	16	16.8	4
1892	89.6	30	45.9	28	60.2	7	17.8	16	29.1	11	14.4	3
1893	53.8	17	58.5	28	77.0	6	28.8	11	34.6	20	2.1	21
1894	67.0	18	43.8	5	67.7	28	35.9	9	14.2	21	61.9	2
1895	34.5	26	62.2	25	115.6	2	21.3	7	39.6	6	5.1	24
1896	46.1	23	80.7	6	72.2	5	13.2	7	20.3	21	0.1	5 15
1897	66.6	26	58.5	28	75.4	14	18.2	1	19.0	21	20.8	31
1898	30.0	18	78.6	8	87.2	16	54.4	13	76.8	12	5.7	23
1899	253.5	19	68.1	19	180.8	20	25.5	19	80.8	14	....	......

V.—MAXIMUM RAINFALLS IN ONE DAY.

In this paragraph we shall examine the greatest quantity of water which has been collected at this observatory in the interval of one day only. With this object in view we have prepared the Table LVI.

MAXIMUM DAILY RAINFALL GREATER THAN 200 MM.

This table shows the greatest maximum of water fell on September 24, 1867, in which day there was registered not less than 336 mm. of water, which was collected during the twenty-four hours of the day. Following this figure, and descending in the named order, was July 30, 1880, July 19, 1899, June 15, 1891, August 2, 1872, and September 15, 1880. On these dates there fell in Manila the following quantities of water respectively: 290.1 mm., 253.5 mm., 252.7 mm., 226.5 mm., 213.1 mm. With these exceptions, the other daily maximums of rainfalls are not less than 200 mm.

DISTRIBUTION OF DAILY AND YEARLY RAINFALLS IN THE DIFFERENT MONTHS OF THE YEAR.

The daily and yearly maximum rainfalls are distributed in the different months of the year in the following manner:

January	1	August	4
May	2	September	9
June	4	October	3
July	11	November	1

The greatest frequency of the maximum of the daily and yearly rainfall takes place in the months of July and September, followed by the months of June, August, and October, and finally May, January, and November, in which last months it is also very rare that a greater quantity of rain is registered in any one day.

REASONS FOR THE GREATER RAINFALLS OBSERVED AT MANILA IN ONE DAY.

Concerning the reasons or causes which produce these maxima of registered rainfalls in Manila in one day, we believe that we can state, without fear of contradiction, that they were caused, at least in the minority of cases, by the influence of the hurricanes or atmospheric perturbations more or less in the neighborhood of Manila. The five maxima of which we have spoken in the above account took place with low barometers and without false indications of depression from the quadrants of the north.

RAINFALLS OF JULY 19, 1899, CAUSED BY THE INFLUENCE OF THE TYPHOON OF SHANGHAI FROM JULY 18 TO 25, 1899.

By way of example we mention briefly the cyclone which was the cause of the great rainfall of July 18, 1899. The English publication which since April last has been issued by this observatory at the end of each month, has this to say concerning the typhoon or cyclone mentioned: "The third typhoon, probably the most noted of the whole month, is the typhoon which extended to Manila principally during the 18th, 19th, and 20th of July." On the 18th the tempest which started in the northeast of Luzón extended its influence and reached simultaneously to a great distance, taking in Japan and the Philippines. At the beginning it seemed to be inclined to move to the west in the direction of the island of Formosa, but afterwards took a turn to the north, as was indicated by our observatory in the forecast for the day of July 21, in which it was stated that the typhoon was already in the suburbs of Shanghai. The accuracy of this forecast of the observatory was proven by the statements published in the newspapers of this colony early on the morning of the 21st, destroying many trees and bringing down the column of the mercury to 736.6 mm.

After making a diagram near the east of Shanghai, the cyclone turned in another direction, from west to east, reaching south of the island of Kiushimu in Japan on July 24. We will give the course followed by this typhoon in chapter 8, Paragraph VI, Engraving XLIV.

In the following paragraph we shall have occasion to see that in no manner whatever can the same be said concerning the greater rainfalls observed in Manila in the short space of one hour, or less than one hour.

TABLE LVII.—*Maximum rainfalls observed in Manila during the period from 1885 to 1899.*

Years.	January.			February.			March.			April.		
	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.
1885	1.0	9	2–3 p.m. 3–4 p.m.	0	0	0	3.0	17	4–5 p.m.	16.0	22	8–9 p.m.
1886	1.5	16	0–1 p.m.	5.5	11	8–9 p.m.	0	0	0	13.3	29	4–5 p.m.
1887	5.0	16	2–3 p.m.	2.8	12	0–1 p.m.	12.4	31	0–1 a.m.	10.8	3	2–3 p.m.
1888	11.5	24	2–3 p.m.	0	0	0	10.8	29	2–3 p.m.	14.0	20	7–8 p.m.
1889	36.0	29	2–3 p.m.	10.7	19	2–3 p.m.	2.5	10	2–3 p.m.	2.5	23	3–4 a.m.
1890	4.2	13	0–1 p.m.	3.0	7	8–9 p.m.	15.4	12	10–11 p.m.	14.6	15	3–4 a.m.
1891	9.5	14	2–3 p.m.	1.1	8	1–2 p.m.	3.3	10	0–1 a.m.	4.0	29	4–5 p.m.
1892	8.4	21	3–4 a.m.	8.2	29	6–7 p.m.	8.5	23	5–6 p.m.	5.0	4	4–5 a.m.
1893	3.0	8	10–11 p.m.	2.5	12	11–12 a.m.	8.0	10	3–4 p.m.	12.0	14	9–10 p.m.
1894	0.9	4	1–2 p.m.	0.8	20	0–1 p.m.	45.8	9	0–1 p.m.	16.3	30	11–12 a.m.
1895	14.5	3	5–6 p.m.	1.4	7	6–7 a.m.	9.6	8	3–4 p.m.	2.0	29	5–6 p.m.
1896	0.4	1 2	2–3 a.m. 6–7 a.m.	5.6	13	3–4 p.m.	2.1	2	0–1 a.m.	3.0	27	2–3 p.m.
1897	5.1	22	1–2 p.m.	0	0	0	9.5	16	5–6 p.m.	10.7	30	10–11 p.m.
1898	17.4	2	11–12 p.m.	2.2	10	4–5 p.m.	6.1	15	3–4 p.m.	14.5	13	1–2 p.m.
1899	7.6	15	3–4 a.m.	1.5	12	10–11 a.m.	5.8	30	2–3 p.m.	16.0	22	6–7 p.m.

Years.	May.			June.			July.			August.		
	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.
1885	1.0	4	4–5 p.m.	34.0	29	5–6 a.m.	27.2	24	3–4 p.m.	25.0	30	8–9 p.m.
1886	16.5	2	2–3 p.m.	24.0	16	3–4 p.m.	30.8	30	0–1 a.m.	42.0	26	5–6 p.m.
1887	36.5	22	9–10 p.m.	55.0	21	8–9 p.m.	31.5	20	8–9 p.m.	20.0	17	7–8 p.m.
1888	4.0	21	7–8 p.m.	27.1	17	7–8 p.m.	42.8	23	4–5 a.m.	47.0	27	2–3 a.m.
1889	0	0	0	47.2	30	2–3 p.m.	32.7	15	6–7 a.m.	48.0	6	1–2 p.m.
1890	10.3	6	2–3 p.m.	27.1	15	3–4 p.m.	50.0	16	5–6 p.m.	20.5	25	7–8 p.m.
1891	42.0	29	7–8 p.m.	55.0	15	7–8 a.m.	26.2	27	9–10 a.m.	22.0	8	7–8 p.m.
1892	60.0	21	5–6 p.m.	11.8	11	11–12 p.m.	40.0	30	0–1 a.m.	20.3	28	5–6 p.m.
1893	13.8	16	9–10 a.m.	5.0	18 28	2–3 p.m. 1–2 p.m.	27.1	9	9–10 p.m.	32.0	21	10–11 p.m.
1894	21.3	10	9–10 p.m.	25.4	28	1–2 p.m.	27.8	18	6–7 p.m.	29.7	5	8–9 p.m.
1895	25.5	13	9–10 a.m.	31.8	26	0–1 a.m.	24.8	18	8–9 p.m.	23.4	3	5–6 p.m.
1896	33.6	17	5–6 a.m.	16.0	6	5–6 p.m.	12.5	23	11–12 a.m.	32.8	28	7–8 p.m.
1897	11.5	28	2–3 p.m.	33.0	16	4–5 p.m.	21.0	26	4–5 p.m.	46.0	28	3–4 p.m.
1898	25.0	10	9–10 p.m.	38.2	10	4–5 a.m.	23.0	17	3–4 p.m.	40.0	8	11–12 p.m.
1899	9.2	16	1–2 p.m.	37.5	28	4–5 p.m.	51.3	19	1–2 a.m.	38.0	19	8–9 p.m.

Table LVII.—*Maximum rainfalls observed in Manila during the period from 1885 to 1899*—Continued.

Years.	September.			October.			November.			December.		
	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milimeters.	Days.	Hours.	Milfmeters.	Days.	Hours.
1885	9.0	17	7–8 p.m.	24.0	6	6–7 p.m.	6.0	17	11–12 p.m.	3.0	3	4–5 p.m.
1886	23.3	18	8–9 a.m.	31.5	10	4–5 p.m.	11.3	5	1–2 a.m.	7.0	19	1–2 p.m.
1887	52.5	18	6–7 p.m.	17.0	5	1–2 p.m.	21.9	26	8–9 a.m.	25.6	5	2–3 p.m.
1888	47.0	17	7–8 p.m.	27.0	9	9–10 p.m.	4.8	16	5–6 p.m.	13.3	5	5–6 p.m.
1889	26.5	10	2–3 a.m.	14.5	18	4–5 p.m.	12.8	4	2–3 a.m.	22.0	9	3–4 p.m.
1890	38.4	10	10–12 p.m.	17.5	14	0–1 p.m.	24.0	11	10–11 a.m.	10.0	19	0–1 p.m.
1891	50.3	15	5–6 p.m.	15.5	9	5–6 p.m.	49.8	16	3–4 p.m.	10.8	3	0–1 a.m.
1892	26.5	13	7–8 a.m.	15.6	7	0–1 a.m.	12.6	4	1–2 p.m.	10.5	26	11–12 p.m.
1893	40.0	18	1–2 a.m.	22.4	11	11–12 p.m.	11.0	22	3–4 p.m.	2.0	22	6–7 a.m.
1894	25.8	15	7–8 p.m.	21.6	22	1–2 p.m.	10.0	3	5–6 p.m.	16.2	2	4–5 a.m.
1895	30.3	11	6–7 p.m.	21.2	7	7–8 p.m.	17.0	6	1–2 p.m.	4.0	24	5–6 a.m.
1896	44.0	6	1–2 a.m.	10.0	12	11–12 p.m		21	2–3 p.m.	0.1	{ 5 15 }	0–1 p.m.
1897	24.5	2	7–8 p.m.	9.7	7	6–7 p.m.	17.7	21	2–3 p.m.	8.5	31	6–7 a.m.
1898	47.2	14	1–2 a.m.	21.8	6	11–12 p.m.	35.5	22	1–2 p.m.	2.4	23	7–8 a.m.
1899	27.4	20	3–4 a.m.	10.5	1	9–10 p.m.	14.3	14	5–6 p.m.	......	.....	....

VI.—MAXIMUM RAINFALLS IN THE SPACE OF ONE HOUR.

OBJECTS OF THIS PARAGRAPH AND ITS UTILITY.

The material treated of in this paragraph is of special interest and utility, for it will explain the major quantities of water which can be expected to fall in Manila in the short space of one hour. With this object in view we have formed Table LVIII, which contains by months the maximum rainfalls observed in Manila in the space of one hour during the period from 1885 to 1899 (until the month of November, inclusive). We expressly begin with the year 1885, for in the register of this observatory anterior to this year we find that the water collected in the pluviometers during the night is given combined with the water collected in the early morning, without specifying the respective quantities of water for each hour.

MOST EXCESSIVE RAINFALLS IN ONE HOUR.

According to this table it will be seen that the greatest quantity of water which fell in the space of one hour in the period of fifteen years was 60 mm., which was on the evening of May 21, 1892. Following this, the quantity collected from 7 to 8 in the morning on June 15, 1891, 55 mm.; from 6 to 7 in the evening of September 18, 1887, 52.7 mm.; from 1 to 2 a. m. of July 19, 1899, 51.3 mm., and from 5 to 6 p. m. on September 15, 1891, 50.3 mm.

REASONS FOR THESE HEAVIER RAINFALLS IN SHORT SPACE OF TIME.

This involves two questions. First, are these heavier rainfalls which precipitate a large quantity of water in a short space of time subject to atmospheric perturbations or to electric tempests in Manila? Second, the rainfalls which are shown in Table LII, are they of uniform quantity during the stated hours or have they been much heavier in some parts of the island than in others, resulting in greater quantities of water falling in one minute? Both of these questions we will answer in Table LVII, showing those which caused a greater quantity of water to fall than 40 mm., and indicating in another column the immediate reason for each one of these rainfalls, and adding, in the last column, some observations with reference to the shortest space of time during the same hour which has been mentioned in which the greatest quantity of water fell and was registered, whenever it has been possible for us to deduce it from the registering apparatus.

The annual maximum of each hour in these fifteen years is distributed in the following manner:

March	1	July	1
May	1	August	4
June	1	September	6

The maximum frequency occurs in September, descending in the following manner: August, June, July, May, and March.

TABLE LVIII.—*Causes and other details of the most abundant rainfalls in Manila in the space of one hour or part of one hour.*

Year.	Date.	Hour.	Quantity of water in millimeters.	Reasons for these rains.	Observations.
1892	May 21	5–6 p.m.	60.0	Intense local tornado	These 60 mm. were registered by the pluviograph Cassella in 30 minutes.
1891	June 15	7–8 a.m.	55.0	Influence of distant pressure.	In 8 minutes 50 mm. were collected.
1887	Sept. 18	6–7 p.m.	52.5	Intense tornadoes	The pluviograph registered 40 mm. in 30 minutes.
1899	July 19	1–2 a.m.	51.3	Tornado influenced by a distant hurricane.	We found 20 mm. registered in 15 minutes.
1891	Sept. 15	5–6 p.m.	50.3	Influence of distant hurricane.	20 mm. were registered in 12 minutes.
1890	July 16	5–6 p.m.	50.0	Distant hurricane in the north.	
1891	Nov. 16	3–4 p.m.	49.8	Influence of a hurricane which crossed near the south of Manila.	
1889	Aug. 6	2–3 p.m.	48.0	Tornado	In 7 minutes 50 mm. were registered.
1889	June 30	2–3 p.m.	47.2	....do	In 20 minutes 30 mm. were registered.
1898	Sept. 11	1–2 a.m.	47.2	Distant pressure	In 17 minutes 25 mm. were registered in the pluviograph.
1888	Aug. 27	2–3 a.m.	47.0	....do	
1888	Sept. 17	7–8 p.m.	47.0	Tornado	45 mm. of water fell in 35 minutes.
1897	Aug. 28	3–4 p.m.	46.0	Intense local tornado	40 mm. registered in 16 minutes.
1894	Mar. 9	0–1 p.m.	45.8	Tornado	
1896	Sept. 6	1–2 a.m.	44.0	....do	20 mm. collected in 15 minutes.
1888	July 23	4–5 a.m.	42.8	....do	
1886	Aug. 26	5–6 p.m.	42.0	....do	15 mm. registered in 15 minutes.
1891	May 29	7–8 p.m.	42.0	....do	20 mm. registered in 10 minutes.

From this table it is evident that the principal reason for the most frequent of these heavy rainfalls, observed in Manila, is not atmospheric perturbations, but is the tornado or electric tempest.

THE ABSOLUTE RAINFALLS IN LESS SPACE OF TIME—AVERAGE CORRESPONDING TO A MINUTE.

Of the eighteen extraordinary and excessive rainfalls which are included in this table, the most noted one—that is, the one during which time the greatest quantity of water fell in the least space of time—is the rain which occurred during the tornadoes of August 28, 1897, in which

40 mm. of water was collected in only sixteen minutes, giving an average of 2.5 mm. by the minute.

Second in importance to this rainfall are those rains caused by other tornadoes on August 6, 1889, May 21, 1892, and May 29, 1891, in which there fell 15 mm. in seven minutes, 60 mm. in thirty minutes, 20 mm. in ten minutes, respectively, giving an average of 21.1 mm. for the first and 2 mm. for the last two mentioned to the minute.

VII.—DAILY VARIATION OF RAINFALLS IN MANILA.

RAINFALLS OBSERVED IN MANILA AT NIGHT, IN THE MORNING, AND IN THE EVENING DURING THE PERIOD FROM 1889 to 1898.

It is not our intention to give here the rainfall in Manila distributed during the twenty-four hours of the day, but merely to show when the rain is most probable during the different months of the year, whether at night, in the morning, or in the evening. With this end in view, we have prepared the following outline in which, taking the period of ten years, we have indicated, by months, the number of times in which rain has been registered from 8 p. m. to 4 a. m., from 4. a. m. to 12 m., and from 12 m. to 8 p.m.

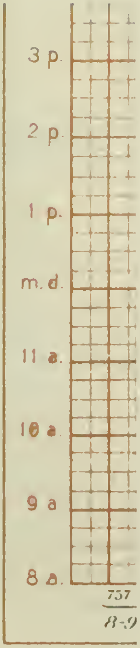
Months.	8 p. m. to 4 a. m.	4 a. m. to 12 m.	12 m. to 8 p. m.
January	11	14	38
February	9	6	16
March	14	17	22
April	15	10	30
May	49	40	83
June	80	65	113
July	121	100	138
August	131	116	140
September	120	107	152
October	78	68	105
November	19	63	77
December	31	50	61
Total	708	656	975

WHEN DO THE MAXIMUM AND MINIMUM OF THESE RAINFALLS TAKE PLACE MOST FREQUENTLY?

Speaking in general of the whole year, the maximum frequency of rainfall is observed in the afternoons and the minimum frequency in the mornings. The difference between the totals of the number of times it has rained in the afternoons and the total rainfalls occurring at night is much greater than that observed between those occurring in the afternoons and in the mornings.

DAILY VARIATION OF RAINFALLS IN THE DIFFERENT MONTHS OF THE YEAR.

Examining each one of the months of the year, we see that without exception there is always more rain in the afternoons than in the evenings during the months of January, March, November, and December, in which months the number of rainfalls occurring in the morning is greater than those of the evenings in other months; but on the other hand the total of these is greater than the total of those.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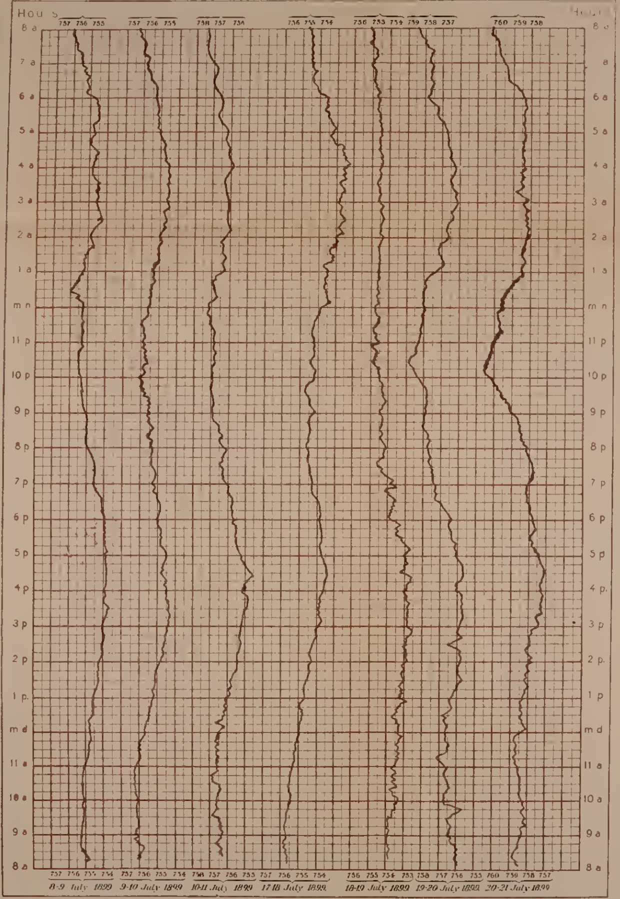
FACSIMILE OF SOME CURVES REGISTERED BY THE SPRUNG-FUESS BAROGRAPH OF THE MANILA OBSERVATORY
IN RAINY DAYS



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VIII.—THE RAIN AND ATMOSPHERIC PRESSURE IN MANILA.

RELATION BETWEEN THE ATMOSPHERIC PRESSURE, AVERAGE DAYS OF RAIN, AND THE NORMAL PRESSURE OF EACH MONTH.

As stated in the first paragraph, concerning the cause of rain in Manila, it may be said that the principal cause is, at least for most months of the year, the atmospheric perturbation which reach the proportions of true cyclonic centers, or it may be simply the effect of areas of low pressure undeveloped. To better illustrate this, we refer to Table LIX, which shows the relation which exists between the atmospheric pressure, average days of rain, and the normal pressure of each month. With this end in view we have computed figures for a period of ten years, from 1889 to 1898, and have deducted the monthly average of this period, only taking into account the days in which there has been any rain registered, and later on we have compared this average with the normal deducted from the same period.

TABLE LIX.—*Barometric average of days of rain and its difference from the normal average during the period from 1889 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1889	761.93	61.51	62.05	59.58	0.0	59.24	57.58	58.01	58.37	58.30	57.27	57.22
1890	758.99	60.72	59.25	58.93	58.28	57.97	57.52	58.22	56.18	57.48	56.31	61.21
1891	759.95	63.45	61.85	59.62	58.41	57.36	56.12	57.88	57.56	59.95	58.22	61.74
1892	761.12	60.25	59.14	60.14	58.89	57.51	57.39	58.43	56.29	57.83	58.71	60.31
1893	761.41	60.53	59.83	58.13	56.81	59.13	57.44	57.26	56.30	58.22	59.33	60.43
1894	759.65	61.40	59.28	60.03	57.63	57.63	57.76	57.54	55.62	58.09	59.37	59.09
1895	760.76	59.37	60.19	59.73	57.62	56.94	57.69	56.87	56.11	58.29	59.33	61.65
1896	760.63	62.53	60.22	59.65	57.33	58.02	55.74	57.07	58.12	58.41	61.03	62.02
1897	762.73	0.0	60.18	59.13	58.44	56.87	58.11	57.15	57.96	58.43	58.69	60.24
1898	760.80	60.53	57.82	58.96	57.73	56.96	57.22	56.27	58.23	57.19	57.00	59.29
Average	760.80	61.11	59.98	59.39	57.91	57.76	57.26	57.47	57.07	58.22	58.53	60.22
Average of normal pressure from 1889–1898	760.87	61.21	60.21	59.38	58.22	57.91	57.55	57.63	57.37	58.33	59.18	60.68
Monthly pressure of the days of rain from 1889–1898	760.80	61.11	59.98	59.39	57.91	57.76	57.26	57.47	57.07	58.22	58.53	60.22
Difference	−0.07	−0.07	−0.26	+0.01	−0.31	−0.15	−0.29	−0.16	−0.30	−0.11	−0.65	−0.46

Average yearly difference, —0.21.

As can be seen by the comparison made in this table, with the exception of April only, during which month the average pressure of the days of rain is nearly equal to the normal, they do not differ more than 0.01. In all the other months of the year the difference between the average pressure and the normal does not reach even 1 mm. The difference in the two yearly averages is —0.24. While this is very insignificant, it is well proven on one hand that the atmospheric perturbations or centers of low pressure are the principal causes of rain in Manila, and on the other hand it indicates the indications in some cases are that the rainfalls are the result of the influence of high pressure and tornadoes, which frequently occur, when the barometer is sent to its normal height.

MONTHS IN WHICH ARE SHOWN THE MAXIMUM AND MINIMUM DIFFERENCES BETWEEN THE PRESSURE, DAYS OF RAIN, AND NORMAL PRESSURE.

The maximum differences —0.65 and —0.46 occur in the months of November and December, in which the tornadoes are very rare, and for this reason it must be noted as the result of the influence of atmospheric perturbations. This same difference, observed in April, has to be attributed to the small number of typhoons that generally present themselves in the same months, and the frequency with which changes are observed with some tornadoes in the second half of the month.

MOVEMENTS OCCASIONED IN THE BAROMETER DURING RAINS AND SQUALLS.

In the Engraving XXXI we give some models of diagrams traced by the barograph Sprung-Fuess of this observatory during days of abundant rains and squalls. The effect of this spiral curve, more or less continued, is to show the frequency of rain, whether less or greater at given points and times.

IX.—MONTHLY DISTRIBUTION OF RAIN IN THE ISLAND OF LUZON.

DATES WHICH WE HAVE BEEN ABLE TO USE FOR THE STUDY OF RAINFALL IN THE PHILIPPINE ARCHIPELAGO.

Before we deal with these last paragraphs concerning the rainfall in the Philippine Archipelago we will say a few words regarding the dates we have been able to use in the study of the distribution of these rains.

In the first place the observations verified in the secondary stations of Luzon will serve our purpose, which, while they are sufficient in number, still have left us with certain difficulties due to the frequent change in the personnel, which does not seem to have been always fully instructed in this matter as we would have desired for this kind of work, and which causes some deficiencies in this work which we find it difficult to arrange. To these difficulties must be added errors in copy and print which we have found in the daily reports and the monthly totals of rainfall at those stations mentioned in the published bulletins of this observatory; for which reason in trying to present here some tables of rainfall in certain points in Luzon, we have found ourselves obliged to refer to the same originals from which they were compiled and which we have examined closely with the desire to utilize only those months and years which merit our full confidence. This means that in the tables which we present here we shall leave blank those observations which seem to us deficient as to the quantity of rain, days of rain, and the maximums of daily rainfall at various points. From this it appears that when the averages are in general the result of number of years which we indicate in a corresponding table, the yearly averages will be deducted in several minor cases because it necessarily depends on the number of years of observation which have been complete, and to us seem correct, from which we have prepared these tables.

Concerning the other islands outside of Luzon, we are indebted to some private persons in the agricultural stations of Iloilo, Cebu, and La Carlota, and several Jesuit missionaries of the island of Mindanao for what data we have been able to procure.

THE YEARLY MARCH OF RAIN IN THE ISLAND OF LUZON.

Having made these indications, we will consider in this paragraph the distribution of rain in the island of Luzon during the different months of the year.

For this reason we have taken 3 stations of the occidental coast, Vigan, Cabo Bolinao, and Punta Santiago; 3 points in the interior of Luzon, Tuguegarao, San Isidro, and Tayabas; and 4 stations on the northern and oriental coast, Aparri, Atimonan, Daet, and Albay.

In Table LX we give the monthly averages of the quantity of rain registered at each of these stations during the periods of years indicated.

TABLE LX.—*Monthly averages of the quantity of rain in the different stations of Luzon.*

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years of observation.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	
Vigan	0.0	0.0	4.3	3.5	89.2	217.4	535.6	289.4	486.1	176.4	65.5	0.3	10
Cabo Bolinao	1.2	1.5	11.3	10.1	122.6	382.5	558.2	525.4	584.0	192.1	31.4	8.1	12
Punta Santiago	6.5	0.2	5.7	4.6	99.4	186.9	368.2	239.9	321.5	120.8	101.6	57.5	12
Daet	252.3	177.9	226.7	81.4	189.5	139.7	211.4	382.2	269.3	313.9	205.6	436.9	2
Atimonan	116.7	81.3	73.3	75.0	163.3	169.1	258.4	178.7	166.8	408.7	530.7	428.5	3
Albay	233.5	168.2	229.0	155.4	188.3	207.6	266.2	242.1	299.9	212.5	301.1	457.0	6
Aparri	230.9	98.8	48.7	27.9	66.9	58.3	129.4	174.1	242.0	285.8	241.0	264.5	9
Tuguegarao	3.4	1.1	11.2	23.2	27.1	52.6	151.6	68.0	76.1	143.8	50.2	89.1	2
San Isidro	15.9	6.5	18.9	23.3	210.1	192.7	339.4	282.9	361.5	168.0	102.0	51.6	10
Tayabas	124.0	48.9	60.2	23.8	100.7	88.6	96.6	73.9	116.5	239.0	283.2	195.4	7

MONTHLY DISTRIBUTION OF RAINFALL ON THE OCCIDENTAL COAST OF LUZON.

According to the averages shown in this table we examine first the yearly march of rain in the first three stations situated in the three different points at large of the occidental coast of Luzon.

We observe two things principally in this examination: First, that in these three stations the dry and rainy season is as distinctly marked as in Manila; second, that in the dry months at these points the precipitation of water is much less than in Manila, and it can be assumed that the precipitation of water there during December, January, February, March, and April amounts to almost nothing.

This difference is attributable to the position which the capital of the archipelago occupies in the background of the bay of Manila, for which reason it is not very far from the oriental coast, and the influence of the currents from the northeast—which are the cause of the great condensations and precipitations of water observed in said oriental coast during the months of high atmospheric pressure—reaches them with greater facility than the other stations of the occidental coast.

Concerning the epoch of the humid or rainy year, the monthly distribution at these three stations which we are considering is very similar to that of Manila, since in all of them the greatest averages are observed in the months of July and September.

Notwithstanding this, the rainfalls appear to be more abundant in Bolinao than in Vigan, and in Vigan more than in Punta Santiago, and in this last one a little less than in Manila.

COMPLETE STATEMENT OF RAINFALL AT THE STATIONS OF BOLINAO AND PUNTA SANTIAGO—MONTHLY AVERAGES.

In order that these yearly marches of rain may be more fully understood as regards the occidental coast of Luzon, we give in Table LXI and LXII two complete statements of the quantity of water collected in both stations during the period from 1886 to 1897.

January and February are the months during which the least rain falls in Bolinao, for, in the twelve years comprised in these tables, during two years in January and three in February only was any rain registered. In Punta Santiago the month during which the least rain falls is February, in which during the period under consideration only one year shows that any water was registered in the pluviometers of this station, and in the following descending order are the months which have not had any rain: April, March, and January, in seven, six, and three years, respectively.

TABLE LXI.—*Quantity of water registered in the pluviometers of Bolinao during the period from 1886 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
1886	13.9	0.0	0.0	0.0	119.0	629.0	454.2	498.5	708.0	130.5	0.0	16.4	2,579.5
1887	0.0	0.0	0.0	29.0	41.0	111.0	538.0	161.0	751.0	151.0	9.0	0.0	1,791.0
1888	0.0	0.0	0.0	......	102.0	463.0	392.0	422.0	......	......	0.0	21.0	....
1889	0.0	0.0	22.0	0.0	25.0	140.0	555.0	726.0	262.0	217.0	35.0	0.0	1,982.0
1890	0.0	0.0	30.0	9.0	200.0	286.0	......	......	547.0	177.0	......	0.0	....
1891	0.0	0.4	0.0	0.0	20.0	751.0	726.0	404.0	793.0	8.0	94.0	0.0	2,796.1
1892	0.0	8.0	68.0	3.0	123.0	691.0	619.0	288.0	1,008.0	188.0	9.0	40.0	3,075.0
1893	1.0	9.0	0.0	0.0	419.0	......	......	307.0	637.0	......	11.0	3.0	....
1894	0.0	0.0	3.0	35.0	66.8	298.8	238.8	326.4	676.2	201.0	38.0	13.0	1,897.0
1895	0.0	0.0	0.0	3.0	197.0	199.3	312.0	1,334.4	442.8	55.3	161.5	0.0	2,705.3
1896	0.0	0.0	13.0	12.0	......	131.0	902.0	962.0	343.6	668.6	0.0	0.0	....
1897	0.0	0.0	0.0	19.6	5.8	507.0	805.0	350.0	255.0	124.8	21.0	4.0	2,092.2
Average	1.2	1.5	11.3	10.1	122.6	382.5	558.2	525.4	584.0	192.1	34.4	8.1	2,364.8

TABLE LXII.—*Quantity of water collected in the pluviometers of Punta Santiago during the period from 1886 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1886	8.0	0.0	0.0	......	......	83.0	191.0	118.9	275.0	150.5	......	31.5	....
1887	8.0	0.0	20.0	36.0	117.5	181.0	161.5	127.0	421.0	68.0	106.5	60.0	1,306.5
1888	0.0	0.0	7.0	0.0	9.0	287.0	1,122.0	367.0	120.0	72.0	44.0	101.0	2,129.0
1889	17.0	0.0	0.0	0.0	0.0	151.0	108.0	261.0	123.0	153.5	269.0	245.0	1,327.5
1890	9.0	0.0	0.0	8.0	62.0	244.0	173.0	81.0	511.5	336.0	210.0	2.0	1,636.5
1891	6.0	0.0	0.0	5.5	0.0	195.0	726.0	317.0	132.0	6.0	75.0	85.0	1,547.5
1892	0.0	0.0	15.0	0.0	17.0	76.0	......	10.0	278.0	11.0	45.0	0.0	....
1893	4.0	0.0	0.0	0.0	100.0	15.0	137.0	36.0	306.0	133.0	103.0	35.0	869.0
1894	5.0	0.0	15.0	0.0	20.0	143.0	255.0	105.0	688.0	146.0	45.0	27.0	1,449.0
1895	13.0	2.0	0.0	0.0	345.0	551.0	276.0	216.0	498.0	41.0	160.5	16.0	2,124.5
1896	7.5	0.0	5.0	0.0	350.0	288.0	692.0	887.0	201.0	109.0	14.0	......	....
1897	0.0	0.0	6.0	1.0	73.0	25.5	209.1	353.0	305.0	220.0	45.5	30.0	1,268.1
Average	6.5	0.2	5.7	4.6	99.4	186.9	368.2	239.9	321.5	120.8	101.6	57.5	1,517.5

Yearly averages of these two stations.—Of Bolinao, 2,364.8 mm. and of Punta Santiago, 1,517.5 mm. These averages differ from those of Manila as follows: 448.2 mm. and 399.2 mm., respectively.

MONTHLY DISTRIBUTION OF RAIN ON THE ORIENTAL COAST OF LUZON.

The monthly distribution of rain on the oriental coast of Luzon is very different from the above, as will be seen by the monthly averages of Atimonan, Daet, and Albay. In these stations it is impossible to recognize any dry and rainy season, which is so marked in the occidental coast. On the other hand, we must confess that the rainfall is very abundant during all the months of the year.

In the months of high pressure the reasons given in the first paragraph apply here as well, and in other months the rains are caused by the influence of atmospheric perturbations principally.

The maximum averages for Albay and Daet are reached in December, and in Atimonan in October, November, and December. The months which show the smallest average are February, April, and May for Albay, and April, June, February, and May for Daet, and February, March, and April for Atimonan. It must be remembered that the averages of Daet are taken from only two years' observations, and those of Atimonan from three years, while those of Albay are the result of six years' observations, and for this reason we give special attention to the latter.

YEARLY MARCH OF RAIN IN THE STATION OF ALBAY.

With this end in view we publish in Table LXIII the statements of rainfalls in this station during the period from 1893 to 1897 and comprising the year 1891.

TABLE LXIII.—*Quantity of water collected in the pluviometers of the station of Albay in the year 1891 and during the period from 1893 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1891	457.5	99.5	130.1	166.9	89.1	232.6	421.1	368.8	84.2	140.8	478.9	690.6	3,360.1
1893	191.5	187.9	358.9	167.6	179.4	207.1	270.0	140.1	217.0	173.1	547.7	695.7	3,336.0
1894	145.3	261.7	271.9	151.5	174.3	365.2	485.4	183.5	489.6	306.2	343.2	469.0	3,649.8
1895	221.8	157.5	321.1	203.7	161.0	181.3	179.8	171.3	485.0	328.2	170.1	366.1	2,949.9
1896	294.1	184.7	128.8	172.6	472.5	223.1	158.4	180.5	119.8	91.6	113.6	236.7	2,706.4
1897	90.7	117.9	163.0	67.4	50.3	36.5	80.3	108.3	373.5	231.9	152.8	283.6	1,761.2
Average	233.5	168.2	229.0	155.4	188.3	207.6	266.2	242.1	299.9	212.5	301.1	457.0	2,960.6

As shown by this table, the yearly minimums of Albay are distributed over the following six months: September, August, January, February, November, and June. The yearly maximums are distributed as follows: Two in the months of December, three in September, and one in August. The yearly average is 2,960.6 mm., which exceeds the yearly average of Manila by 1,044 mm.

MONTHLY DISTRIBUTION OF RAINFALL IN THE NORTH COAST OF LUZON.

In the stations situated as Aparri is, on the northern coast of Luzon, the yearly distribution of rainfall is very similar to what we have just stated in regard to the oriental coast, at least in regard to the months of

August–January. During the rest of the year, February–July, the precipitation of water is less abundant and the months are similar to those of some months which we have included in the so-called dry season of Manila.

MONTHLY DISTRIBUTION OF RAIN IN THE INTERIOR OF LUZON.

Concerning the yearly march of rainfall in the interior of Luzon, we may say in general that it is more or less similar to that of Manila and the occidental coast or to the villages on the oriental coast which are far from the said coasts. So, as seen in Table LX, in Fayabas, which is quite near the oriental coast, the distribution of rain is small, as observed in Albay, Daet, and Atimonan, though there is more rain in the last-mentioned one, and yet we may say that the dry and rainy season is divided into the period from February to August, for the first, and September to January for the second.

It appears that in Fuguegarao the quantity of rain which falls during the year is much less than at other points in the interior of Luzon, although we were able to utilize the observations of two years for this study. It is impossible to give the monthly averages of this station any other value than a provisional one, for which reason we do not enter into any more details concerning the relation of these averages.

COMPLETE STATEMENT FROM THE STATION OF SAN ISIDRO (NUEVA ECIJA).

In San Isido it will be seen by the monthly averages we give in Table LX, and by the statements which have gone before in Table LXIV, which comprise the pluviometric observations of this station from 1888 to 1897, the yearly march of rain is very similar to that of Manila, with the exception that the average for the month of May is greater than in this station. We believe in general that the same averages would be even more similar to those of Manila if the number of years of observation were greater. The yearly average of 1,815.2 mm. differs from the yearly average of Manila by only 65.4 mm.

Table LXIV.—*Quantity of water collected in the pluviometers of the station of San Isidro during the period from 1888 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
1888	0	0	90.5	29	224	261	424.1	265	224	162	62	68	1,809.6
1889	115	0	19	20	64	156	187	218	308	228	172	181	1,668.0
1890	7	13	20	59	208	164	193	192	782	251.5	91	7	1,987.5
1891	6	0	2	6	64	418	400	441	406	82	237	74	2,136.0
1892	0	2	8	2	......	145	76.8	......	53.6	......	91	9	....
1893	0	11	0	65	438	131	359	156.7	420.2	177.5	121.2	4	1,883.6
1894	28	30	2	2	86	219	572	241	444	214	54	27	1,919.0
1895	0	2	0	0	437	274	293	367	431	83	68	1	1,956.0
1896	0	6	7	0	156	77	495	474	......	191	......	0	....
1897	3	1	40	50	214	82	394	191	185	123	22	145	1,450.0
Average	15.9	6.5	18.9	23.3	210.1	192.7	339.4	282.9	361.5	168.0	102.0	51.6	1,851.2

CONCLUSION—THE YEARLY VARIATION OF RAIN IS VERY DIFFERENT IN THE VARIOUS PARTS OF LUZON.

From what we have said in this paragraph it is evident how great is the yearly variation of rain in the various parts of Luzon, and how correct what we said in the beginning concerning the so-called rainy

PLATE XXVII.

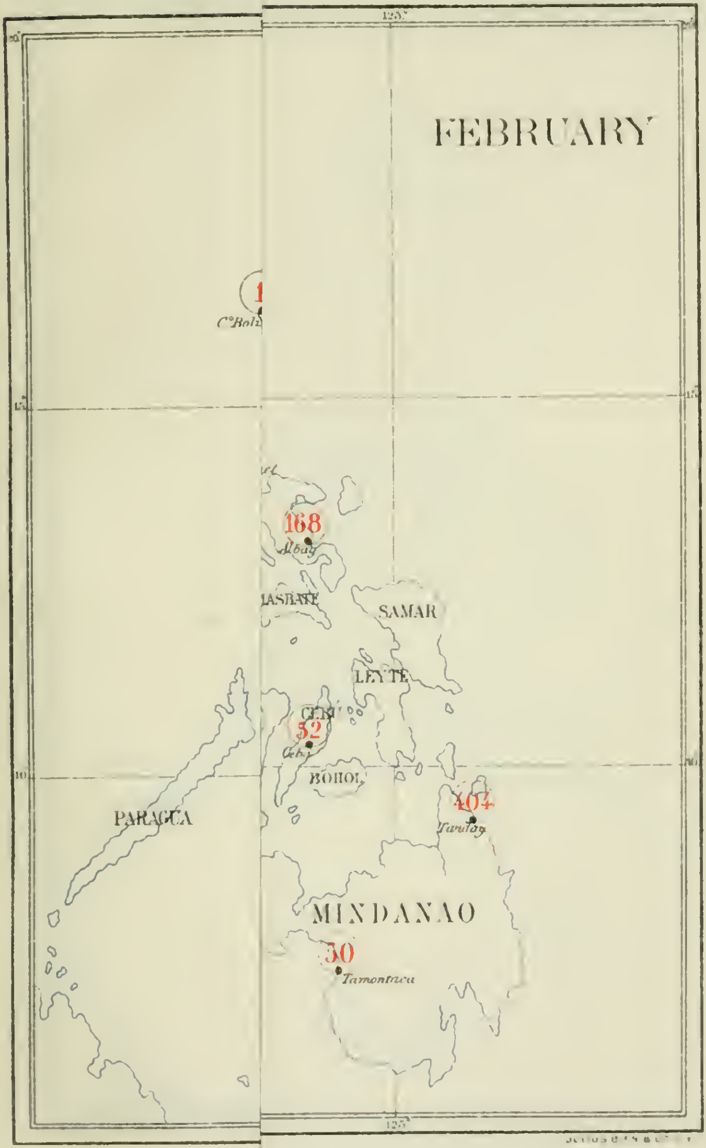
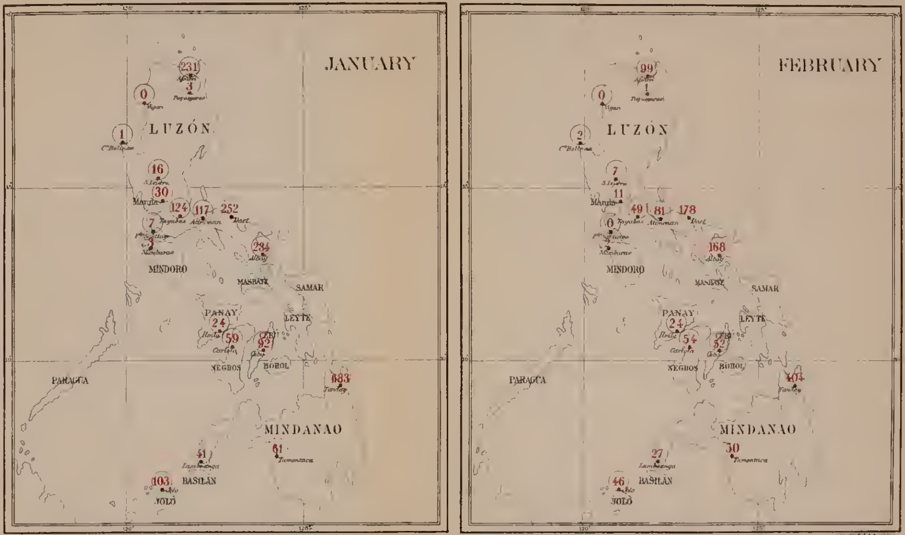

125°
20
FEBRUARY
1
C°Boli
15
168
Albay
ASBATE
SAMAR
LEYTE
CEB
52
Cebu
BOHOL
10
PARAGUA
404
Tandag
MINDANAO
30
Tamontaca
125°

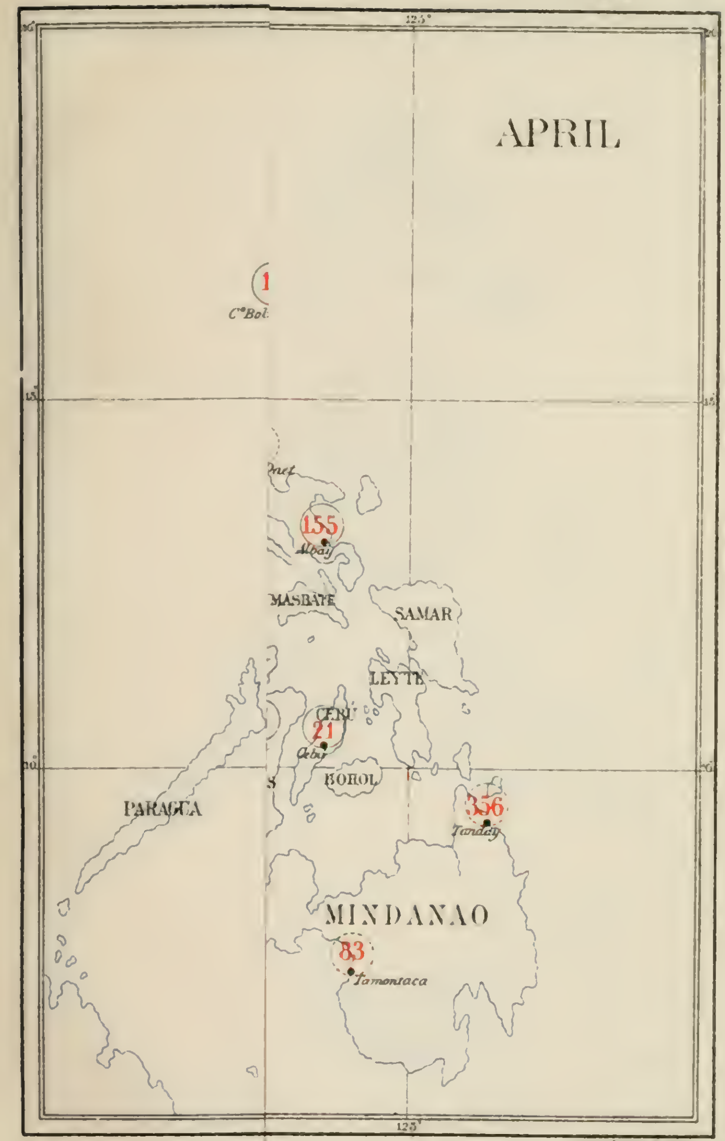
PLATE XXVII.



Monthly distribution of rain in the Philippine Archipelago

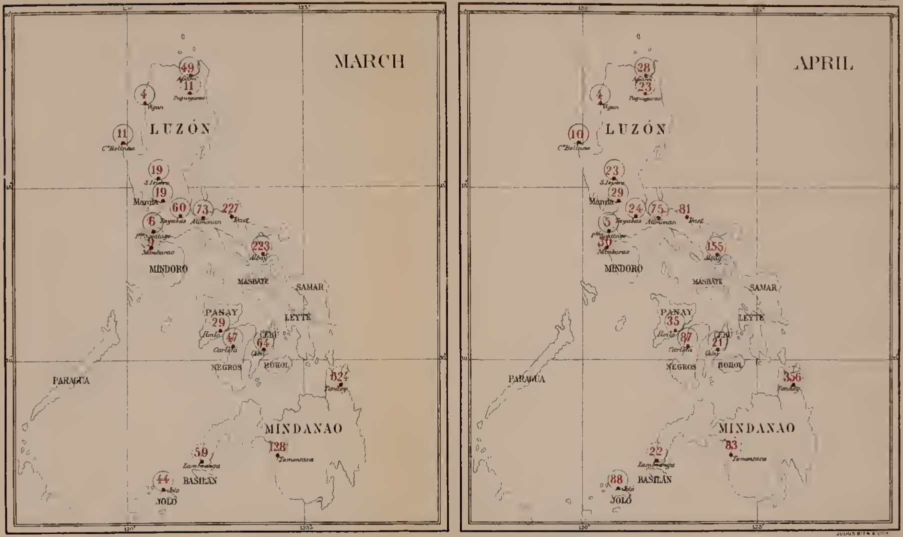
Longitude E of Greenwich

PLATE XXVIII.



JULIUS BIEN & CO. N.Y.

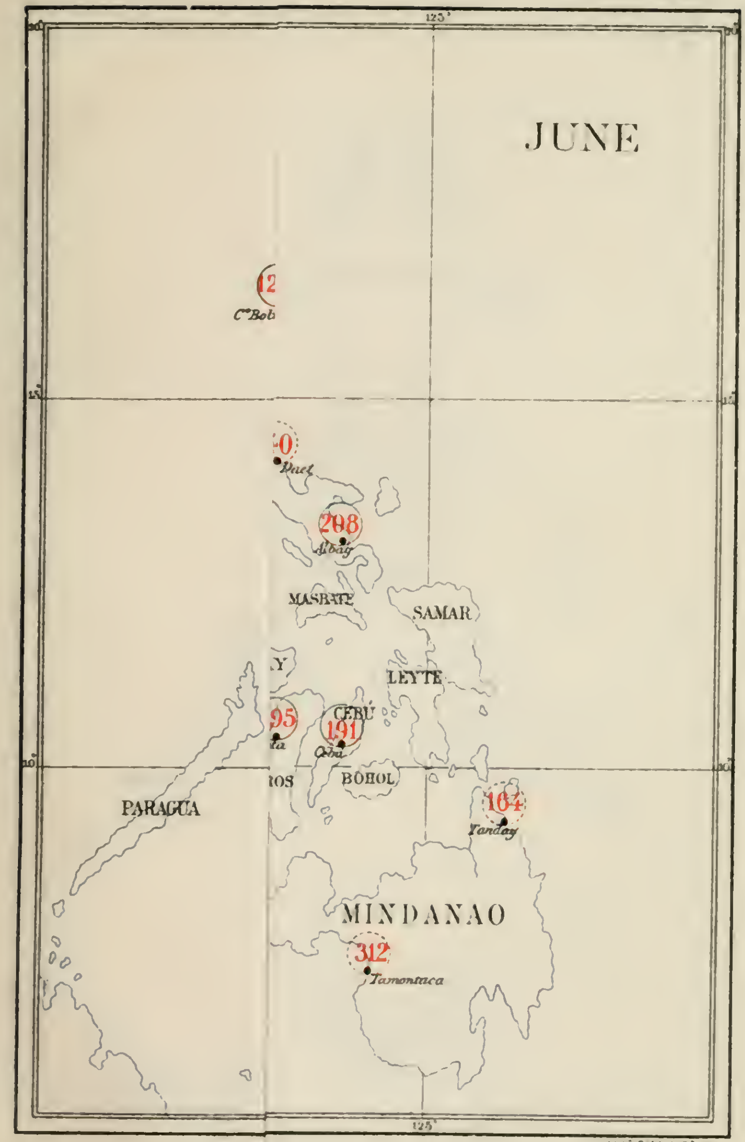
PLATE XXVIII.



Monthly distribution of rain in the Philippine Archipelago

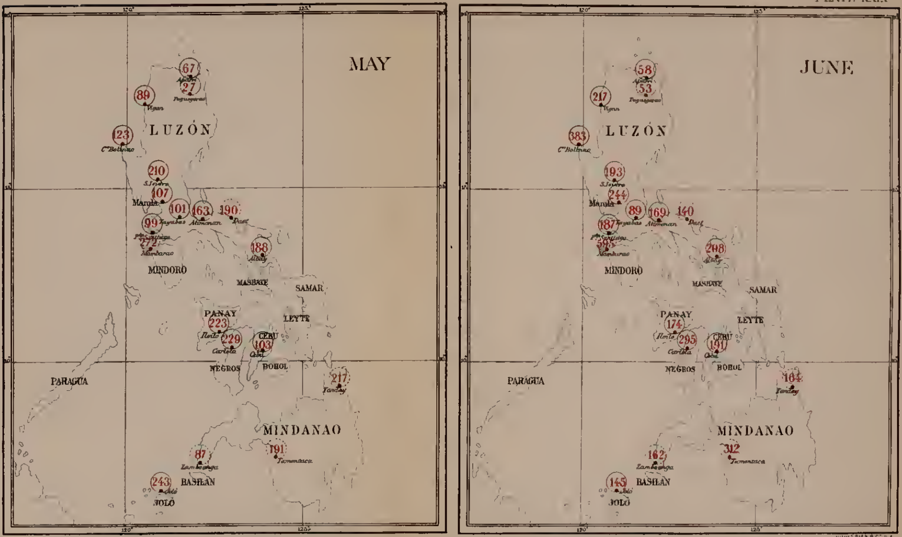
Longitude E. of Greenwich

PLATE XXIX.



JULIUS BIEN & C° N.Y.

PLATE XXIX



Monthly distribution of rain in the Philippine Archipelago

Longitude E of Greenwich

PLATE XXX.

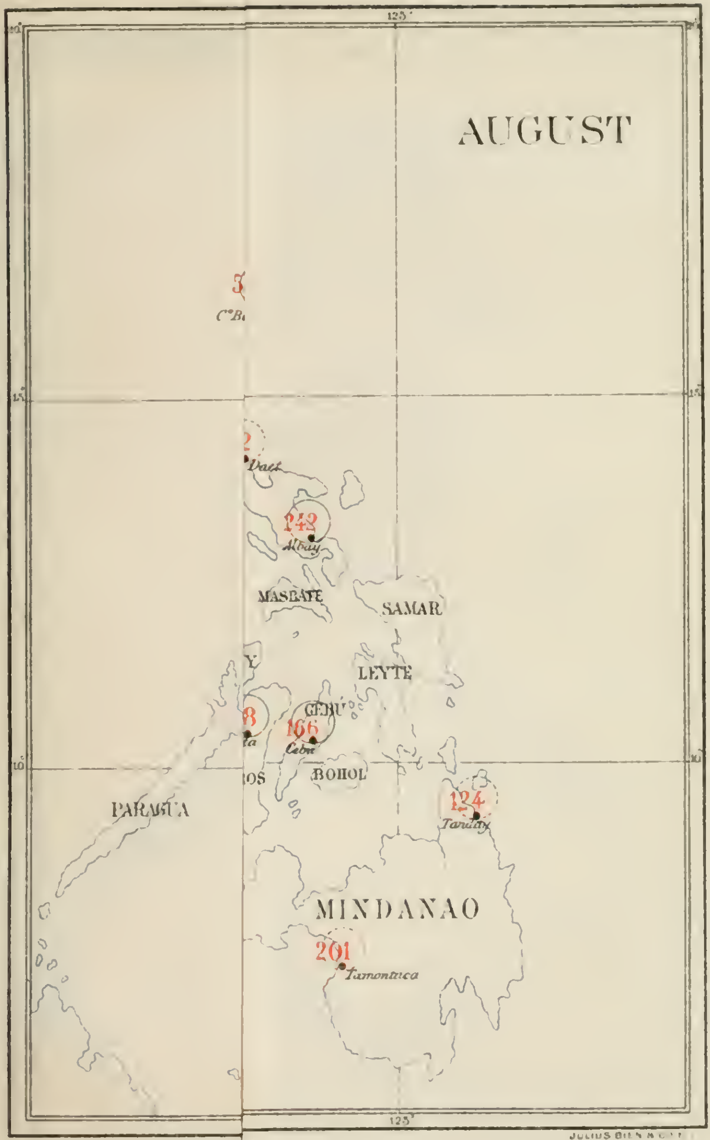


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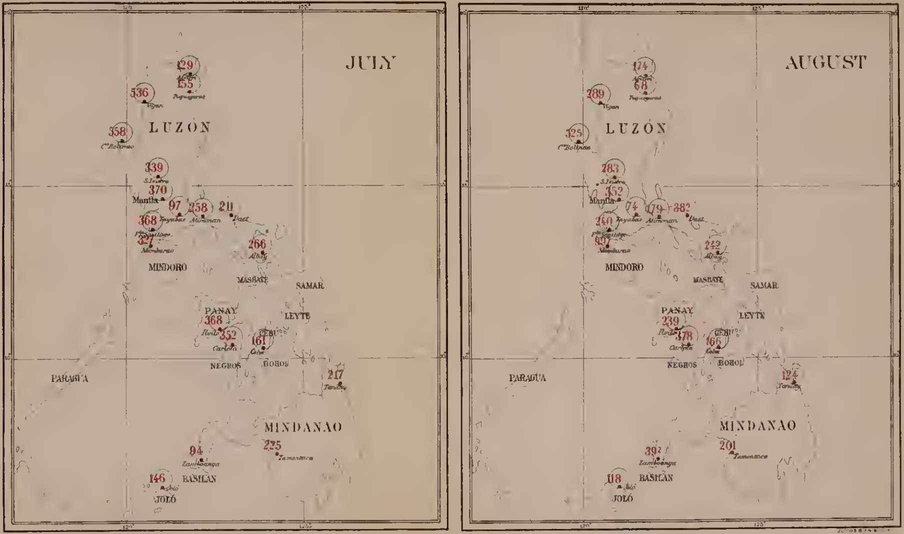
PLATE XXX.



Monthly distribution of rain in the Philippine Archipelago

Longitude E of Greenwich

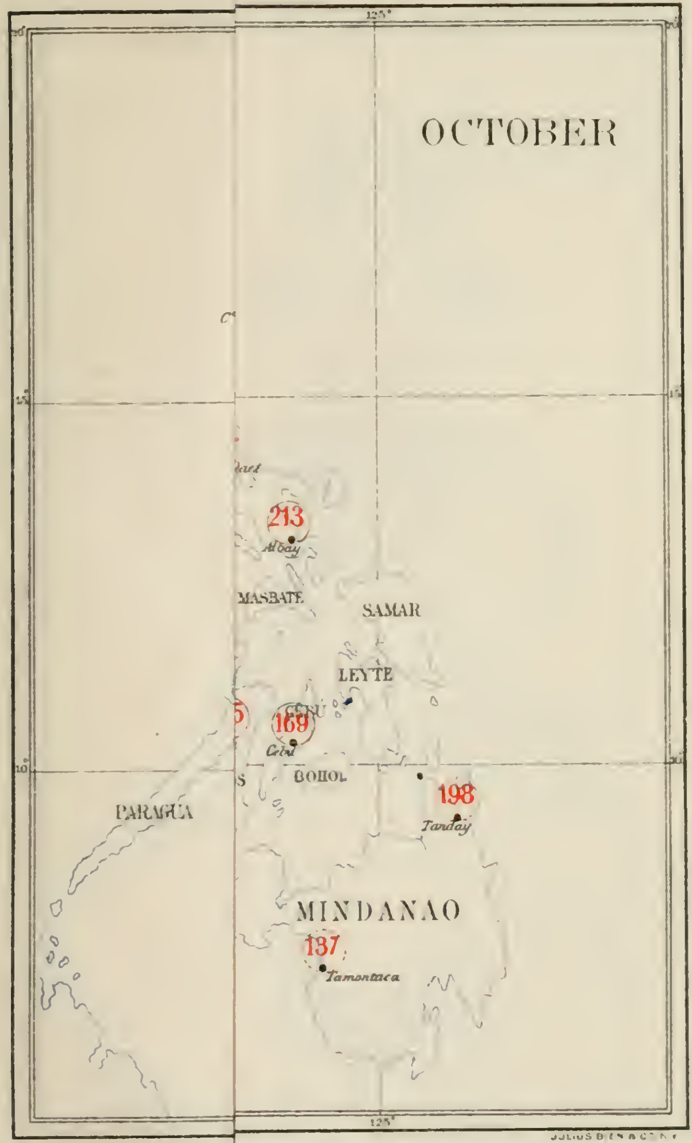
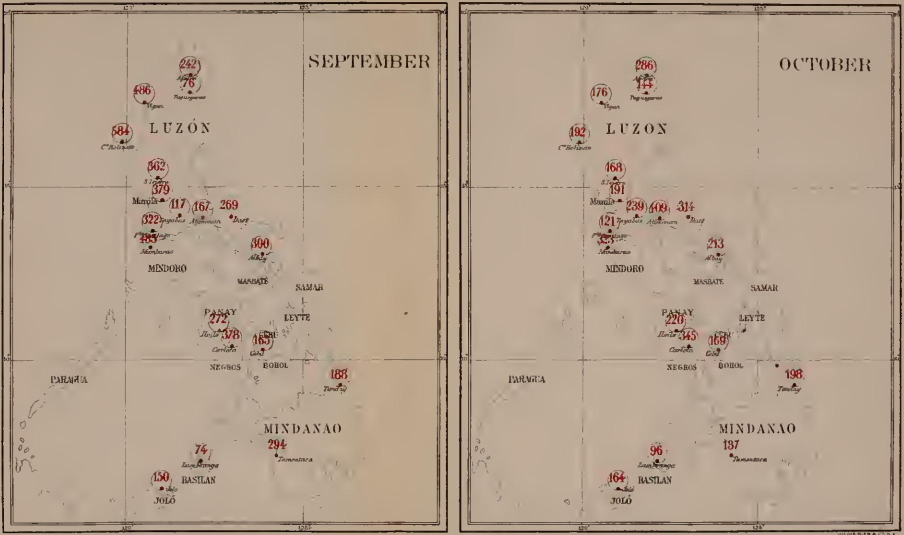

OCTOBER
125°
213
Albay
MASBATE
SAMAR
LEYTE
CEBU
169
Cebu
BOHOL
198
Tanday
PARAGUA
MINDANAO
137
Tamontaca
10°
15°
20°
JULIUS BIEN & CO. N.Y.

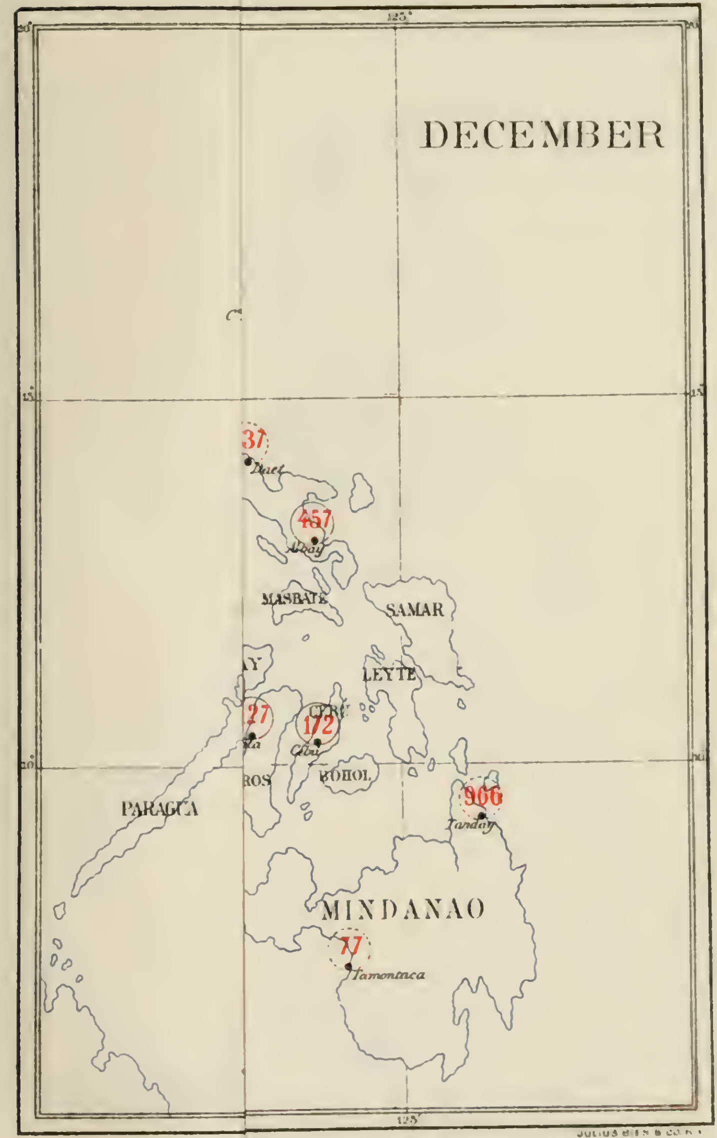
PLATE XXXI



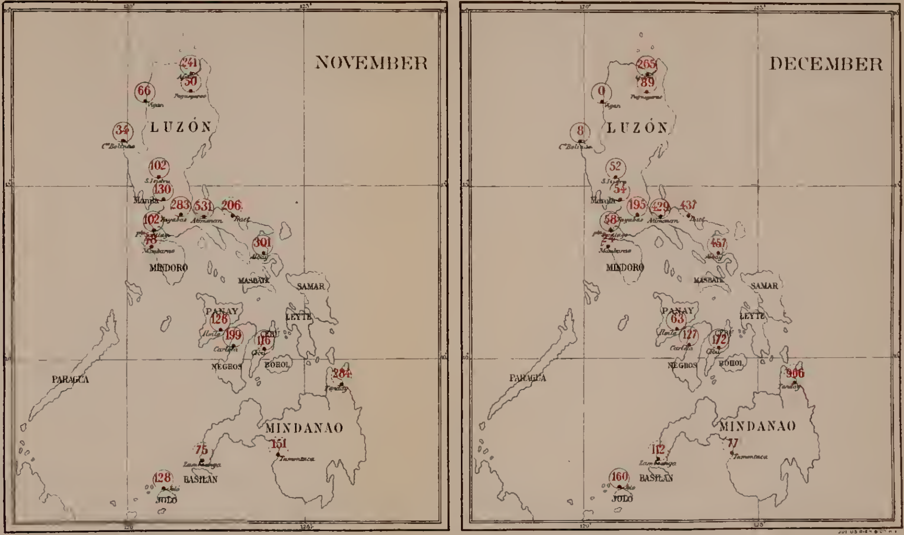
Monthly distribution of rain in the Philippine Archipelago

Longitude E. of Greenwich

PLATE XXXII



JULIUS BIEN & CO. N.Y.



Monthly distribution of rain in the Philippine Archipelago

Longitude E of Greenwich

PLATE XXXIII

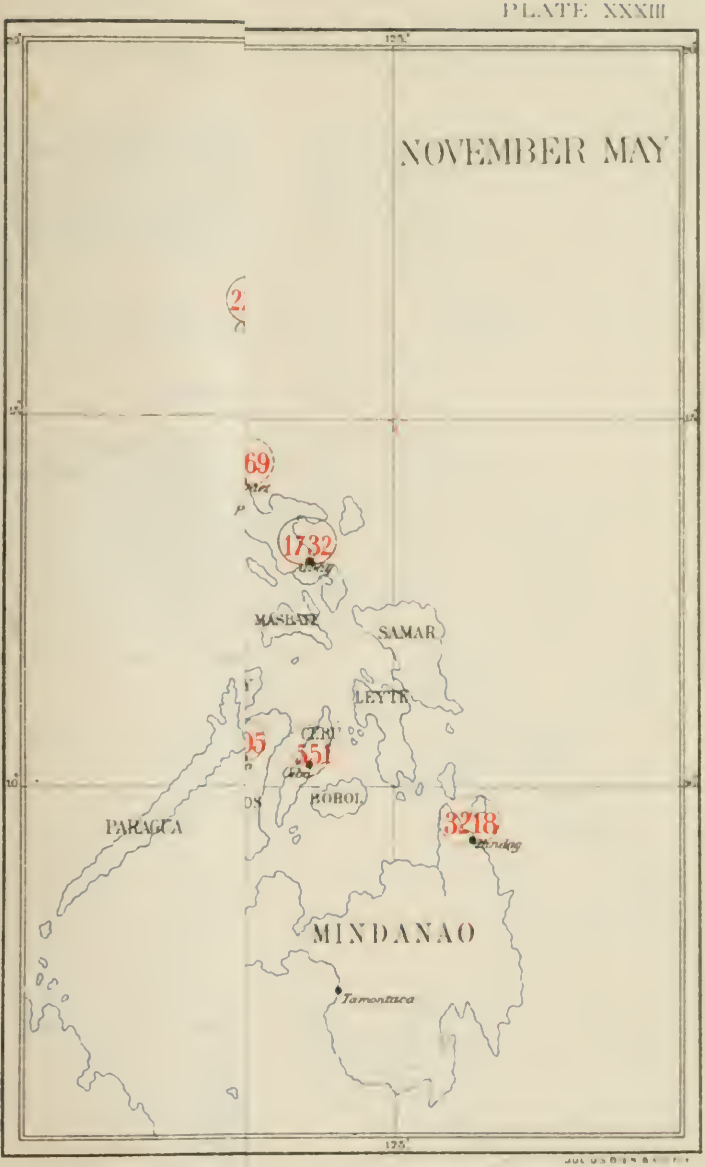
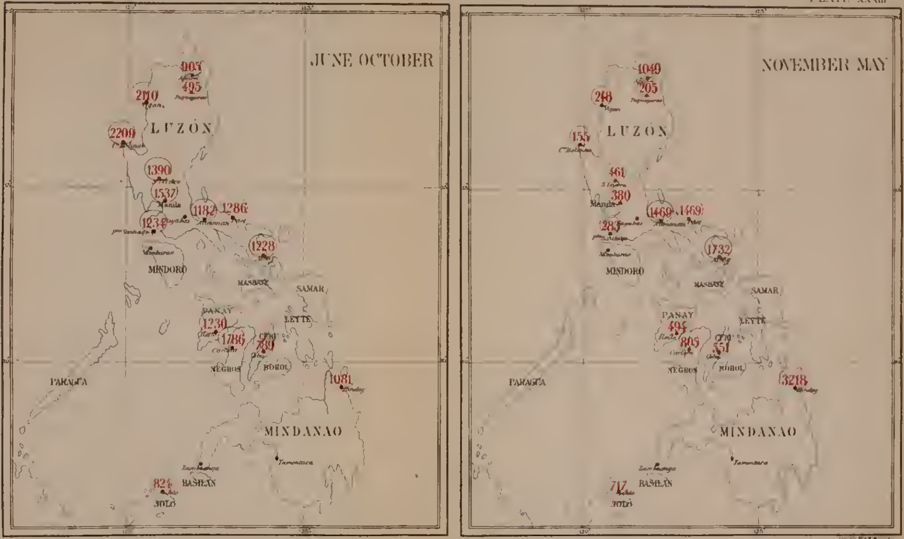


PLATE XXXIII



Semi annual distribution of rain in the Philippine Archipelago

Longitude E. of Greenwich

and dry season. This, however, can be applied only to the occidental coasts, and partly, but not in a uniform manner, to the stations of the center of Luzon.

MAPS OF THE MONTHLY AND HALF-YEARLY DISTRIBUTION OF RAIN IN THE PHILIPPINE ARCHIPELAGO.

That the monthly and half-yearly distributions of rain may be the more readily seen in the different stations which we have selected for this study of the island of Luzon, and those which we shall hereafter select from the other islands, we give in the seven accompanying engravings the monthly and half-yearly averages of rain in the different points of the archipelago.

X.—DAILY MAXIMUM RAINFALL IN THE DIFFERENT POINTS OF LUZON.

OBJECT OF THE FOLLOWING TABLES.

In this paragraph we will give year by year and month by month the maximum rainfalls observed in the interval of one day in the stations of Bolinao, Punta Santiago, San Isidro, and Albay. This will be the object of Tables LXV, LXVI, LXVII, and LXVIII. In Table LXIX will appear the daily maximum rainfalls observed in each month of the year in the said four stations, and in several other parts of the island of Luzon.

TABLE LXV.—*Daily maximum rainfalls observed in the station of Bolinao in each one of the months during 1886 to 1897.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1886	10.5 (19)	0	0	0	50 (15)	158 (15)	56 (16)	117.5 (27)	75 (17)	49 (9)	0	6 (20, 23)
1887	0	0	0	23 (3)	25 (19)	19 (30)	117 (20)	30 (13)	135 (20)	51 (5)	9 (9)	0
1888	0	0	0	....	35 (28)	150 (16)	150 (14)	170 (3)	....	....	0	21 (22)
1889	0	0	22 (19)	0	25 (14)	40 (29)	115 (16)	125 (23)	75 (10)	70 (13)	35 (1)	0
1890	0	0	30 (25)	9 (30)	77 (26)	101 (5)	95 (18)	23 (7, 23)	202 (12)	90 (1)	....	0
1891	0	0.4 (18)	0	0	20 (11)	155 (15)	143 (19)	53 (8)	101 (8)	6 (19)	78 (17)	0
1992	0	8 (4)	34 (3)	2 (4)	19 (22)	136 (10)	128 (24)	71 (30)	158 (8)	102 (29)	3 (12, 22)	40 (26)
1893	1 (11)	6 (9)	0	0	106 (27)	31 (20)	217 (18)	59 (7)	91 (9)	....	9 (21)	2 (24)
1894	0	0	2 (28)	32 (1)	16 (1)	58 (29)	74 (1)	18.6 (10)	116 (18)	82 (4)	23 (18)	8 (4)
1895	0	0	0	3 (26)	84 (24)	70 (25)	105 (27)	225 (25)	95.2 (22)	23 (15)	95.1 (3)	0
1896	0	0	10 (12)	8 (28)	....	37 (8)	200 (18)	310 (30)	95.6 (20)	190 (12)	0	0
1897	0	0	0	12 (18)	5 (29)	116 (23)	158 (28)	42 (11)	72 (16)	38.5 (3)	20 (10)	4 (17)

TABLE LXVI.—*Daily maximum rainfalls observed in the station of Punta Santiago during each month of the years from 1886 to 1897.*

Year.	January.	February.	March.	April.	May.	June.
1886	4 (17)	0	0	......	......	25 (1)
1887	5 (1)	0	14 (28)	30 (2)	73 (7)	85 (5)
1888	0	0	7 (22)	0	7 (14)	70 (29)
1889	8 (14)	0	0	0	0	70 (29)
1890	6 (16)	0	0	8 (28)	40 (1)	126 (28)
1891	5 (6)	0	0	5.5 (9)	0	55 (13)
1892	0	0	13 (25)	0	11 (22)	31 (9)
1893	4 (2)	0	0	0	75 (6)	15 (8)
1894	5 (1)	0	15 (23)	0	10 (10, 28)	80 (28)
1895	7 (6)	2 (7)	0	0	136 (11)	175 (27)
1896	3 (1)	0	0	0	62 (9)	158 (6)
1897	0	0	5 (5)	1 (13)	25 (20)	16 (13)

Year.	July.	August.	September.	October.	November.	December.
1886	74 (24)	70 (29)	60 (21)	47 (15)	......	8 (21)
1887	90 (20)	40 (2)	90 (20)	25 (2)	23 (9)	32 (12)
1888	179.5 (28)	104 (3)	48 (8)	35 (4)	15 (16)	65 (6)
1889	19 (5)	62 (5)	20 (14)	80 (29)	123 (4)	87 (3)
1890	35 (16, 21)	20 (1, 8)	115.5 (29)	135 (17)	127 (11)	2 (23)
1891	197 (26)	52 (30)	86 (3)	4 (14)	30 (28)	40 (23)
1892	40 (18)	7 (3)	64 (5)	6 (7)	35 (12)	0
1893	29 (30)	25 (28)	92 (26)	75 (1)	70 (22)	35 (27)
1894	47 (19)	25 (31)	262 (17)	87 (10)	10 (22)	10 (2)
1895	70 (27)	41 (6)	104 (2)	16 (2)	76 (5)	3 (25)
1896	83 (23)	220 (2)	75 (8)	25 (29)	3 (22)	......
1897	63 (26)	86 (9)	116 (14)	46 (17)	17.5 (15)	10 (23)

TABLE LXVII.—*Daily maximum rainfalls observed at the station of San Isidro for each month from 1888 to 1897.*

Year.	January.	February.	March.	April.	May.	June.
1888	0	0	57 (23)	19 (30)	88 (24)	52 (16)
1889	76 (8)	0	15 (20)	20 (30)	24 (23)	66 (20)
1890	3 (14)	13 (8)	10 (5)	24 (5)	46 (3)	35 (3)
1891	3 (5)	0	1 (14, 29)	3 (12)	28 (22)	65 (12)
1892	0	1 (4, 5)	8 (1)	2 (14)	......	46 (27)
1893	0	7 (6)	0	48 (15)	69 (28)	25 (26)
1894	28 (14)	17 (4)	2 (1)	2 (2)	15 (24)	54 (29)
1895	0	2 (7)	0	0	97 (14)	62 (27)
1896	0	6 (15)	6 (31)	0	30 (23)	28 (7)
1897	2 (22)	1 (11)	30 (21)	20 (21)	80 (5)	18 (22)

Year.	July.	August.	September.	October.	November.	December.
1888	80 (14)	33 (21)	56 (12)	47 (10)	23 (17)	28 (19)
1889	42 (16)	21 (22)	56 (1)	87 (19)	59 (6)	52 (4)
1890	40 (17)	38 (4)	385 (30)	50 (18)	60 (12)	7 (28)
1891	58 (22)	67 (11)	93 (28)	38 (24)	65 (17, 29)	28 (27)
1892	17 (9)	45 (26)	12 (13)	47 (7)	63 (13)	5 (7)
1893	80 (14, 17)	48 (18)	76 (5)	120 (1)	41 (23)	4 (28)
1894	140 (7)	73 (14)	100 (18)	63 (8)	25 (19)	16 (3)
1895	100 (16)	78 (14)	142 (17)	21 (3)	16 (2)	1 (24)
1896	95 (29)	64 (3)	......	80 (10)	2 (3)	0
1897	43 (25, 26)	40 (18)	39 (15)	65 (2)	6 (5)	50 (22)

TABLE LXVIII.—*Daily maximum rainfalls observed in the station of Albay during each one of the months of the year 1891, and during the period from 1893 to 1897.*

Year.	January.	February.	March.	April.	May.	June.
1891	124.2 (13)	46.8 (22)	45 (27)	27.2 (22)	19.5 (25)	55.1 (3)
1893	40 (21)	77.5 (20)	150 (17)	42.5 (9)	40.6 (13)	32.7 (8)
1894	46.6 (15)	54.3 (11)	68.3 (12)	33.5 (4)	39.1 (20)	84.2 (26)
1895	66.5 (4)	34.8 (22)	88.8 (7)	59.7 (2)	48.1 (10)	44.1 (9)
1896	70 (3)	70 (7)	20.5 (4)	49.5 (21)	179.1 (5)	50 (27)
1897	23.4 (1)	31 (7)	42.7 (15)	18.6 (14)	12.4 (10)	20.2 (9)

Year.	July.	August.	September.	October.	November.	December.
1891	115 (25)	67.9 (16)	24.6 (16)	34.5 (18)	198.9 (13)	157.5 (23)
1893	87.3 (24)	43.5 (3)	38.6 (30)	44.5 (28)	168.7 (16)	179 (15)
1894	99.6 (19)	45 (21)	106.5 (27)	67.7 (3)	61.3 (23)	95.9 (9)
1895	47.2 (23)	40.9 (30)	74 (16)	87.5 (9)	76.7 (7)	124 (31)
1896	27 (4)	86.6 (4)	27.3 (4)	22.5 (14)	46.5 (24)	65.3 (25)
1897	29.8 (26)	25.9 (3)	92.8 (12)	59.3 (17)	25.1 (4)	50.4 (4)

TABLE LXIX.—*Daily maximum rainfalls, in millimeters, of several stations of Luzon, corresponding each one to the months of the year.*

Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Years of observation.
Vigan:													
Maximum	0	0	35	15	145	95	200	328	215	200	175	3	10
Date	....	....	1, 1892	4, 1890	4, 1896	12, 1891	9, 1895	10, 1888	20, 1890	9, 1896	2, 1895	1, 1894	
Bolinao:													
Maximum	10.5	8	34	32	106	158	217	340	202	190	95.1	40	12
Date	19, 1886	4, 1892	3, 1892	1, 1894	27, 1893	15, 1886	18, 1893	30, 1896	12, 1890	12, 1896	3, 1895	26, 1892	
Santiago:													
Maximum	8	2	15	30	136	175	197	220	262	135	127	87	12
Date	14, 1889	7, 1895	23, 1894	2, 1887	11, 1895	27, 1895	26, 1891	2, 1896	17, 1894	17, 1890	11, 1890	2, 1889	
Daet:													
Maximum	78	95.1	135	49.5	111.1	46	71	175	173.7	128	38	118.2	2
Date	21, 1898	27, 1898	5, 1896	22, 1896	22, 1896	29, 1896	16, 1896	7, 1896	14, 1897	27, 1896	20, 1896	4, 1897	
Atimonan:													
Maximum	65.5	47	58.5	65.5	104.5	40.5	84	74.8	108	132	204.4	233.5	3
Date	1, 1887	9, 1887	21, 1887	9, 1888	16, 1887	5, 1887	12, 1885	21, 1887	19, 1884	27, 1888	22, 1887	31, 1886	
Albay:													
Maximum	124.2	[illegible]7.5	150	59.7	179.1	84.2	115	86.6	106.5	87.5	198.9	179	6
Date	13, 1891	20, 1893	17, 1893	2, 1895	5, 1896	26, 1894	25, 1891	1, 1896	27, 1894	9, 1895	13, 1891	15, 1893	
Aparri:													
Maximum	171	43	50	45	45.5	35.3	77.5	60	107	131	90	90	9
Date	13, 1886	2, 1886	20, 1892	26, 1895	9, 1886	28, 1895	27, 1895	24, 1897 19, 1892	10, 1895	2, 1897	13, 1890	11, 1892	
San Ysidro:													
Maximum	76	17	57	48	97	68	140	78	385	120	65	52	10
Date	8, 1889	4, 1894	23, 1888	15, 1893	14, 1895	27, 1895	7, 1894	14, 1895	30, 1890	1, 1893	17, 29, 1891	4, 1889	
Tayabas:													
Maximum	95	27	38	24	220	75.5	45	29	125	174	195	63.5	7
Date	31, 1895	12, 1893	16, 1892	29, 1895	15, 1893	25, 1892	29, 1892	2[illegible], 1893	17, 1894	3, 1894	14, 1891	2, 1894	

STATIONS IN WHICH THE MOST ABUNDANT RAINS HAVE FALLEN.

From all these tables can be deduced the fact that the most abundant rains have been observed principally in the stations situated on the occidental coasts. Of all the stations included in Table LXIX, San Isidro shows the greatest maximum rainfall—385 mm. This was observed on September 13, 1890. Next in order is Bolinao, with 340 mm., on August 30, 1896, and then Vigan, with 328 mm., on August 10, 1888.

XI.—MONTHLY DISTRIBUTION OF DAYS OF RAIN IN THE ISLAND OF LUZON.

MONTHLY AVERAGE DAYS OF RAIN IN THE DIFFERENT POINTS OF THE ISLAND OF LUZON.

In Tables LXX, LXXI, LXXII, and LXXIII, following the same order of the previous paragraph, we publish the statements of the days of rain at the stations of Cabo Bolinao, Punta Santiago, San Isidro, and Albay. In Table LXXIV we give the united monthly average days of rain corresponding to these and several other stations in the island of Luzon. The relation which is observed between them is very similar to that observed before in the monthly averages of rainfall collected in the same stations, and as much as has been said on this point can easily be applied to the average number of days of the month and yearly rainfall, and which is the object of the following tables:

TABLE LXX.—*Days of rainfall in the station of Cabo Bolinao during the period from 1886 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1886	3	0	0	0	9	15	22	23	22	5	0	4	103
1887	0	0	0	2	4	9	17	11	16	7	1	0	67
1888	0	0	0	......	7	16	17	16	......	......	0	1	......
1889	0	0	1	0	1	16	18	18	12	9	1	0	76
1890	0	0	1	1	7	11	13	18	17	12	6	0	86
1891	0	1	0	0	1	14	19	25	25	2	5	0	92
1892	0	1	4	2	6	18	18	19	21	8	4	1	102
1893	1	3	0	0	11	11	12	18	18	......	2	2	......
1894	0	0	2	3	11	20	19	18	18	10	4	3	108
1895	0	0	0	1	10	10	12	18	17	4	6	0	78
1896	0	0	2	2	10	12	16	17	15	10	0	0	84
1897	0	0	0	4	3	14	21	16	11	8	2	1	80
Average	0.3	0.4	0.8	1.4	6.9	14.1	17.0	18.1	17.5	7.5	2.6	1.0	87.7

TABLE LXXI.—*Days of rainfall in the station of Punta Santiago during the period from 1886 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1886	3	0	0	3	2	10	12	7	17	14	.....	8	......
1887	2	0	3	4	10	6	9	12	21	12	12	5	96
1888	0	0	1	0	2	9	23	10	10	9	5	3	72
1889	4	0	0	0	0	12	14	17	12	8	11	11	89
1890	2	0	0	1	4	9	11	6	18	19	5	1	76
1891	2	0	0	1	0	10	15	13	7	2	6	4	60
1892	0	0	2	0	2	4	8	2	10	2	2	0	32
1893	1	0	0	0	4	1	8	4	11	5	5	1	40
1894	1	0	1	0	2	4	18	14	17	9	15	7	88
1895	6	1	0	0	12	15	19	19	23	7	9	10	121
1896	3	0	0	0	17	12	21	27	11	15	7	......	......
1897	0	0	2	1	9	6	16	16	13	12	6	6	87
Average	2.0	0.1	0.8	0.8	5.3	8.2	14.5	12.3	11.4	9.5	7.5	5.1	76.1

TABLE LXXII.—*Days of rainfall in the station of San Isidro during the period from 1888 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1888	0	0	4	3	9	19	27	21	22	13	8	6	132
1889	6	0	3	1	8	16	18	21	21	19	12	11	136
1890	3	1	3	6	18	13	18	15	24	16	6	1	124
1891	3	0	2	3	7	20	21	27	24	4	9	11	131
1892	0	2	1	1	5	8	17	12	13	8	5	4	76
1893	0	2	0	6	16	12	17	19	24	9	6	1	112
1894	1	3	1	1	15	15	24	17	19	9	5	3	113
1895	0	1	0	0	18	13	14	21	27	11	11	1	117
1896	0	1	2	0	15	11	23	27	......	14	1	0	....
1897	2	1	2	4	9	11	19	18	12	10	......	8	....
Average	1.5	1.1	1.8	2.5	12.0	13.8	19.8	19.8	20.7	11.3	7.0	4.6	117.6

TABLE LXXIII.—*Days of rainfall in the station of Albay in each one of the months of the year 1891, and during the period from 1893 to 1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1891	25	9	14	13	10	19	25	24	8	13	17	30	207
1893	21	18	16	13	13	20	15	22	21	16	23	25	223
1894	18	19	16	17	13	21	24	21	24	20	21	27	241
1895	20	14	19	13	15	19	16	16	23	15	14	19	203
1896	24	15	19	13	23	19	21	23	16	13	17	24	227
1897	20	16	14	13	16	9	17	23	23	16	19	24	210
Average	21.3	15.2	16.3	13.7	15.0	17.8	19.7	21.5	19.2	15.5	18.5	24.8	218.5

TABLE LXXIV.—*Monthly averages of the days of rainfall in the different stations of Luzon.*

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years of observation.
Vigan	0.2	0	0.2	0.7	2.9	10.0	13.8	13.9	15.8	5.0	1.9	0.1	10
Bolinao	0.3	0.4	0.8	1.4	6.9	14.1	17.0	18.1	17.5	7.5	2.6	1.0	12
Santiago	2.0	0.1	0.8	0.8	5.3	8.2	14.5	12.3	14.4	9.5	7,5	5.1	12
Dáet	21.5	11.5	18.0	9.5	12.5	11.5	15.0	17.5	14.0	21.0	19.0	24.0	2
Atimonan	16.7	10.3	7.7	6.7	10.3	13.3	18.3	15.0	12.0	22.0	22.3	21.0	3
Albay	21.3	15.2	16.3	13.7	15.0	17.8	19.7	21.5	19.2	15.5	18.5	24.8	6
Aparri	11.7	6.1	5.7	3.2	5.4	5.3	7.5	10.5	12.3	11.4	14.6	16.3	9
Fuguegarao	2.0	1.0	4.0	3.5	5.0	14.0	16.5	10.0	14.0	15.5	8.5	14.5	2
San Ysidro	1.5	1.1	1.8	2.5	12.0	13.8	19.8	19.8	20.7	11.3	7.0	4.6	10
Fayabas	10.4	7.7	8.1	5.5	9.9	13.0	12.7	12.6	15.0	15.0	14.1	18.7	7

XII.—MONTHLY DISTRIBUTION OF RAIN AND DAYS OF RAIN IN OTHER POINTS OF THE PHILIPPINE ARCHIPELAGO.

STATISTICS OF RAIN AT THE MODEL FARM "LA CARLOTA."

At the beginning of Paragraph IX we indicated that outside of the island of Luzon there were very few pluviometric observations which we could obtain, these stations not yet having been established in the other islands of the archipelago, and no official meteorologic stations at which data could be obtained. The most complete statistics which we could find in the registers of this observatory are those of the model farm La Carlota (Occidental Negros), which embrace the period of ten years from 1889 to 1898, which statistics are given in the following table:

TABLE LXXV.—*Quantity of water collected in the pluviometer of La Corlota during the period from 1889 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1889	10.1	25.9	8.5	3.0	44.4	287.5	369.5	357.0	317.9	370.8	368.4	262.9	2,425.9
1890	101.6	141.7	48.2	292.9	201.0	259,7	419.0	402.9	511.6	400.0	202.2	13.0	3,023.8
1891	179.9	60.4	61.4	30.3	101.7	175.9	581.5	588.0	290.8	254.2	245.4	225.9	2,798.4
1892	28.8	14.5	62.9	104.9	180.9	346.8	252.6	333.4	151.8	887.8	208.4	188.7	3,064.5
1893	10.4	144.5	50.5	20.0	477.0	409.0	282.5	275.0	379.0	287.6	182.5	222.4	2,740.4
1894	33.5	12.0	14.5	182.8	203.0	267.5	114.9	232.0	623.4	167.0	116.0	83.0	2,079.6
1895	135.5	82.6	47.0	37.0	262.0	415.0	347.5	336.9	313.0	106.6	148.4	38.0	2,269.5
1896	6.0	19.0	20.5	43.5	372.0	230.4	607.0	547.0	231.0	339.5	47.5	9.0	2,175.4
1897	31.5	0.0	113.0	69.0	222.0	351.0	221.0	335.0	112.0	311.6	242.0	103.0	2,441.1
1898	52.0	40.0	......	......	......	211.0	287.0	377.0	241.0	289.0	......	......	....
Average	58.9	51.1	47.4	87.0	229.3	295.4	351.6	378.4	378.1	341.7	199.0	127.3	2,591.3

TABLE LXXVI.—*Days of rain in the agricultural station of La Corlota during the period from 1889 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.	Total.
1889	1	2	1	1	6	26	21	20	22	25	17	19	167
1890	16	8	3	13	23	18	22	19	22	20	10	2	176
1891	13	2	3	6	6	17	22	27	18	16	21	12	163
1892	6	3	6	8	11	18	22	23	19	23	20	15	177
1893	2	6	4	2	11	27	21	21	21	14	15	11	158
1894	5	2	3	13	16	16	16	17	21	17	10	9	145
1895	9	5	5	4	13	20	16	18	17	12	10	4	133
1896	2	3	4	6	15	19	22	22	14	15	5	2	129
1897	3	......	3	6	17	13	16	20	19	17	15	12	141
1898	5	5	......	......	......	15	21	17	18	22	......	......	....
Average	6.5	3.6	3.9	6.6	13.8	18.9	19.9	20.4	19.1	18.1	13.7	9.6	154.3

From Table LXXV it can be understood that the distribution of water in La Corlota during the months from June to September is very similar to that of Manila; also in the matter of monthly averages and in the relation of some months to others, but is different during the period from October to May, in which the precipitation of water is much more abundant than in Manila, but, notwithstanding the dry season covering the period from December to April, both months inclusive, can be easily distinguished. The yearly average is 2,591.3 mm. and is higher than the yearly average in Manila of 674.7 mm.

PLUVIOMETRIC DATA OF OTHER POINTS—VISAYAS AND MINDANAO.

The data which we have in hand from other points generally cover only two years; although those of Iloilo, Cebu, and Jolo cover longer periods, still they are considered deficient and incomplete in some months. For this reason, we have simply given the average quantity and days of rain in eight stations situated in different points of the islands south of Luzon, whose names and the periods of observation can be seen in the same tables.

Table LXXVII.—*Monthly average quantity of rain in the different points, Visayas and Mindanao.*

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years of observation.
Mamburao	3.2	2.3	9.4	29.9	271.8	595.0	327.0	997.1	485.4	323.3	48.2	23.7	2
Zamboanga	41.2	27.0	58.5	21.8	86.6	162.4	94.1	39.1	73.6	95.6	74.6	111.6	2
Jolo	103.1	45.6	44.2	88.3	243.3	144.8	145.9	117.8	149.5	163.9	127.8	160.2	5
Iloilo	23.5	24.1	29.3	34.5	222.9	174.2	367.8	238.8	272.0	220.1	126.0	63.1	4
Cebu	91.6	52.1	64.0	21.2	102.6	191.4	160.8	165.8	165.2	169.4	116.3	171.7	6
Tamontaca	61.4	50.3	128.0	82.8	191.2	312.3	224.8	200.6	293.8	136.5	151.2	76.7	2
Davao	283.5	124.8	71.0	161.7	123.8	197.9	247.6	160.7	159.5	234.8	66.6	208.5	2
Tandag	682.5	403.6	624.4	356.3	217.4	164.3	217.1	123.7	187.5	198.3	284.1	966.0	2

Table LXXVIII.—*Monthly average days of rain in the different points of Visayas and Mindanao.*

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Years of observation.
Mamburao	2.5	3.0	4.0	5.0	13.0	22.0	26.5	24.5	20.5	17.0	4.5	5.0	2
Zamboanga	11.0	7.0	9.0	5.0	10.0	12.5	12.5	9.0	10.0	13.0	11.0	11.0	2
Jolo	5.5	2.5	3.7	4.5	13.0	10.3	11.7	9.0	9.0	13.0	8.7	10.3	5
Yloilo	3.3	3.8	5.3	6.8	11.5	17.8	18.3	22.0	20.0	16.7	13.8	13.3	4
Cebú	11.0	11.2	10.8	6.6	10.2	16.8	16.0	15.8	14.4	15.0	14.2	19.0	6
Tamontaca	6.0	5.0	9.0	8.0	11.3	13.0	16.5	12.0	13.0	9.5	10.5	7.5	2
Dávao	17.5	10.0	14.5	13.0	17.0	18.0	19.0	17.0	14.0	19.0	15.0	13.0	2
Tándag	27.5	22.0	23.0	23.5	15.0	15.5	14.5	12.5	10.0	12.5	19.0	28.0	2

YEARLY MARCH OF RAIN ON THE OCCIDENTAL COAST OF MINDORO.

Taking these tables as a basis, we will say a few words about the yearly march of rain in the islands south of Luzon. First of all it can be seen by the observations of Manburao, a village situated west of Mindoroand, that the two seasons—dry and rainy—are easily distinguished, as in the case of the occidental coasts of Luzon, and that the precipitation of water is very insignificant from December to April, and very abundant from June to October. Only in the month of August, 1898, do we see collected 1,295.5 mm. of water, which, united with the average for this month in 1897, 698.6 mm., gives us an average of 997.1 mm., an extraordinary average, and which would undoubtedly have been less if the number of years had been extended.

MONTHLY DISTRIBUTION OF RAIN IN ZAMBOANGA AND JOLO.

We can learn but little from the averages of Zamboanga, as deducted from only two years of observation, in which two months were incomplete, for the study of distribution of rain in this region. Of greater value are the averages of Jolo, which have been deducted from a period of five years, and if it is true that some of them are incomplete in some months, it is equally true that no average is shown, which have been the result of at least three years of observation. As appears from these averages, the rainfalls there are less abundant than in Manila during the rainy season, but a little more abundant during the dry season. The months in which it rains least are February, March, and April.

The month of May presents the maximum average, which is also very similar to the averages of the other months of the year. We believe that a longer period of observation would show a greater maximum average.

THE RAINFALLS OF ILOILO, CEBU, AND TAMONTACA—DRY AND RAINY SEASON.

In these stations the dry and rainy seasons are very distinct, though not in a uniform manner, as in the case of Manila and the occidental coast of Luzon. The dry season embraces the months of December, January, February, March, and April, and is more pronounced in Iloilo than in Cebu or Tamontaca. The average given for the month of May seems to be applicable to the other months of other stations, though we believe that when the period of observation is extended the average will be diminished. During the rainy season the averages are more abundant in Iloilo and Tamontaca than in Cebu. This last-named city is situated in the eastern part of the island of Cebu and has some precipitation of rain and presents somewhat of the udometric conditions of this season in the oriental coast of the archipelago during the months of December and January, the results of which show the averages for these two months to be as high as 171.7 mm. and 91.6 mm.

YEARLY MARCH OF RAIN IN THE LARGE ORIENTAL COAST OF MINDANAO.

The station of Tandag is situated on the northwest coast of Mindanao, and is very convenient for the study of the yearly distribution of rain at large on the oriental coast of this island. We have been benefited by the observations made by the observatory there, which were verified by the missionary, Father Francisco Sanchez, of the Jesuits, during the two years he was stationed there, and we give the result in averages in Table LXXVII. Similar to the state of rain on the oriental coast of Luzon is the rainy season on the oriental coast of Mindanao, and here the high pressure from the northwest predominates, particularly as to the rains on the west coast of Mindanao, which are more abundant and constant than in the stations east of the island of Luzon, and yet more than those observed in Manila and the occidental coasts during the months from July to September. Only in the month of December of 1897 there was collected in Fandag 1,321.1 mm. of water, and 610.8 mm. in the same month in 1896. For these regions, contrary to the conditions in Manila, the months in which it rains least are June, July, August, September, and October, notwithstanding the fact that the averages for these months, as seen in Table LXXVII, is greater than 100 mm. It must be understood that the yearly average is much higher than that of Manila. The total amount of rain collected in Fandag during the year 1897 was 4,299.2 mm.

IMPORTANT ADVICE.

We can not close this paragraph without inserting the one idea which we have already indicated; that is, that the averages which appear in Table LXXVII, and in the maps of the monthly distribution of rain in the Philippine Archipelago, concerning the station of Visayas and Mindanao, are only provisional with the exception of the model farm

La Carlota. For this reason, in the said maps, we have inclosed in a limited circle by one line of periods the averages which have been deducted from only two years of observation so that they can be distinguished easily from those of a greater number of years of observation, which last are inclosed in a limited circle by a continuous line.

THE RAINFALL IN MANILA IN THE TWO SEASONS OF THE YEAR COMPARED WITH THE RAINFALL IN OTHER POINTS OF THE PHILIPPINE ARCHIPELAGO.

The monthly distribution of rain is very different in the various parts of the archipelago. Table LXXIX shows the yearly average of rain in the different stations of the archipelago divided into two periods, from June to October, and November to May, and gives Pluviometric data of Jap (Occidental Carolines) and San Louis de Apra (Guam, Mariana Islands).

MONTHLY DISTRIBUTION OF RAIN IS VERY DIFFERENT IN THE VARIOUS POINTS OF THE ARCHIPELAGO.

We have already, in preceding chapters, compared the yearly distribution of rain in the several points of the archipelago several times with the yearly distribution in Manila. This comparison will be more apparent if we divide the yearly amount of rain at the different meteorologic stations in the same two groups of months in which we have divided the rainfall of Manila in Paragraph III; that is, into the dry and rainy seasons. In this way it can be readily seen that this division into the dry and rainy seasons can not in any way be applied to the entire archipelago, because the months which in one region constitute the dry season in another region constitute the rainy season.

Even at the points where it appears that the division of the year into the dry and rainy seasons may be admitted, the characteristic differences between both are in some localities more pronounced than in others, as may be seen by the topographic conditions of the same and their greater or less proximity to the oriental or occidental coasts of the archipelago, as indicated by us in some other places.

This is the object of Table LXXIX. In it we give the averages of the total amount of rain corresponding to the periods of the year from November to May and June to October. Beginning with Manila, we put the occidental stations of Luzon and Mindoro, following after several villages of the center of the island, in the second place; and end with Aparri and several stations of the oriental coast of Luzon and Mindanao. To the averages of the partial totals we add also, as we did in Paragraph III, the percentage of yearly averages. From the points in Mindanao, as in Fándag, Daves, and Mati, we have only one year's observations, but we like to include them; giving at the same time the average of the partial amounts corresponding to the two periods of the year and the percentage of the yearly amount.

PLUVIOMETRIC DATA OF JAP (OCCIDENTAL CAROLINES) AND SAN LUIS DE APRA (GUAM, MARIANA ISLANDS).

Besides, we may add to the end of the table, by way of index, the pluviometric datas of Jap and San Louis de Apra during the one year of observation (1896) for the first, and two years (1896 and 1897) for the last named.

The only thing we can say about them is that in both the dry and rainy season is slightly distinguished, while in San Louis de Apra the difference is more pronounced.

TABLE LXXIX.—*Yearly average rainfall in several places of the archipelago divided into two periods—June to October and November to May.*

Stations.	November to May.		June to October.	
	mm.	*Per ct.*	*mm.*	*Per ct.*
Manila (34 years)	379.5	20	1,537.1	80
Vigan (3 years)	247.7	11	2,109.6	89
Bolinao (8 years)	155.4	7	2,209.1	93
Punta Santiago (9 years)	283.2	19	1,234.3	81
Dáet (1 year)	1,468.6	53	1,285.9	47
Munonan (3 years)	1,468.8	55	1,181.7	45
Albay (6 years)	1,732.4	59	1,228.2	41
Apacei (2 years)	1,019.2	54	905.2	46
Fuguegacao (2 years)	205.2	29	491.9	71
San Ysidro (8 years)	461.2	25	1,390	75
Fayabas (1 year)	1,002	61	640.8	39
La Carlota (9 years)	805.1	31	1,785.9	69
Toló (2 years)	716.6	47	823.9	53
Iloilo (3 years)	491.4	29	1,229.5	71
Cebú (2 years)	550.5	41	788.8	59
Dávas (1 year)	963.8	49	995.3	51
Fándag (1 year)	3,218.3	75	1,080.9	25
Mati, southeast of Mindanao (1 year)	905.8	66	467.5	34
Jap, Carolinas Occidentales (1 year)	731.9	39	1,160.1	61
San Luis de Apra, Guam, Mariana Islands (2 years)	303.3	24	951.9	76

The observations of the year 1896 are incomplete for the months of January, February, and March, in which we find only one or two signs of rain, the quantity of which has not been measured; however, the data of the other months is very complete, although we could not prescind from said year anything but the average of rain during the dry season, which resulted in less than if the observations had been continuously made.

XIV.—YEARLY RAINFALL IN THE PHILIPPINES COMPARED WITH SOME OF THE PRINCIPAL POINTS OF THE EXTREME ORIENT AND OF THE UNITED STATES.

We give herewith some data which will serve to compare the proper rainfalls of these islands with those of the other regions of the extreme Orient and with the United States. For this object we have selected the following stations of the archipelago: Manila, Bolinao, Punta Santiago, San Ysidro, Albay, La Carlota, Iloilo, Cebu, Jolo, and Fandag. From the extreme Orient we take the following points: Hongkong, Zikawei (Shanghai), Tokyo, Jap (Occidental Carolines), and San Luis de Apra. At last, from the United States, we name only San Francisco, Chicago, New York, New Orleans, and Key West. Between San Luis de Apra and California we put Honolulu (Hawaii). Besides this, at the end, we add two stations from the Antilles, namely, Habana and San Juan de Porto Rico.

OUTLINE OF THE YEARLY AVERAGE OF RAIN FROM SEVERAL POINTS OF THE EXTREME ORIENT AND THE UNITED STATES.

In the following outline our readers may see the yearly averages of rain in each one of the stations we have just indicated and the period of years from which they have been deduced:

Stations.	Yearly average.	Years of observation.
	mm.	
Manila	1916.6	34
Bolinao	2364.8	8
Punta Santiago	1517.5	9
San Ysidro	1851.2	8
Albay	2960.6	6
La Carlota	2591.3	9
Iloilo	1723.9	3
Cebu	1339.3	2
Jolo	1540.5	2
Fandag	4299.2	1
Hongkong	*a* 2205.9	....
Zikawei, Shanghai	*b* 1119.0	24
Tokyo, Japan	*c* 1467.6	21
Iap (Occidental Carolines)	1895.0	1
San Luis de Apra, Guam, Marianas	1255.2	2
Honolulu	*d* 1004.3	16
San Francisco	*e* 594.4	47
Chicago	*e* 863.6	30
New York	*e* 1135.4	61
Washington	*e* 1089.6	41
New Orleans	*c* 1531.6	26
Key West	*e* 970.3	49
Habana	*d* 1314.2	30
San Juan de Porto Rico	*d* 1510.0	14

a From the publication Observations and Researches, made at Hongkong in the year 1898, page 8.
b From the monthly bulletin of 1896, Observatory of Zikawei, page 217.
c From the yearly report of the Central Meteorological Observatory of Japan for the year 1896, part 1, page 3.
c Data taken from the memoirs Rainfall of the United States, by Alfred J. Henry.
d Data taken from the report of the Chief of the Weather Bureau, 1897–98, pages 316 and 320.

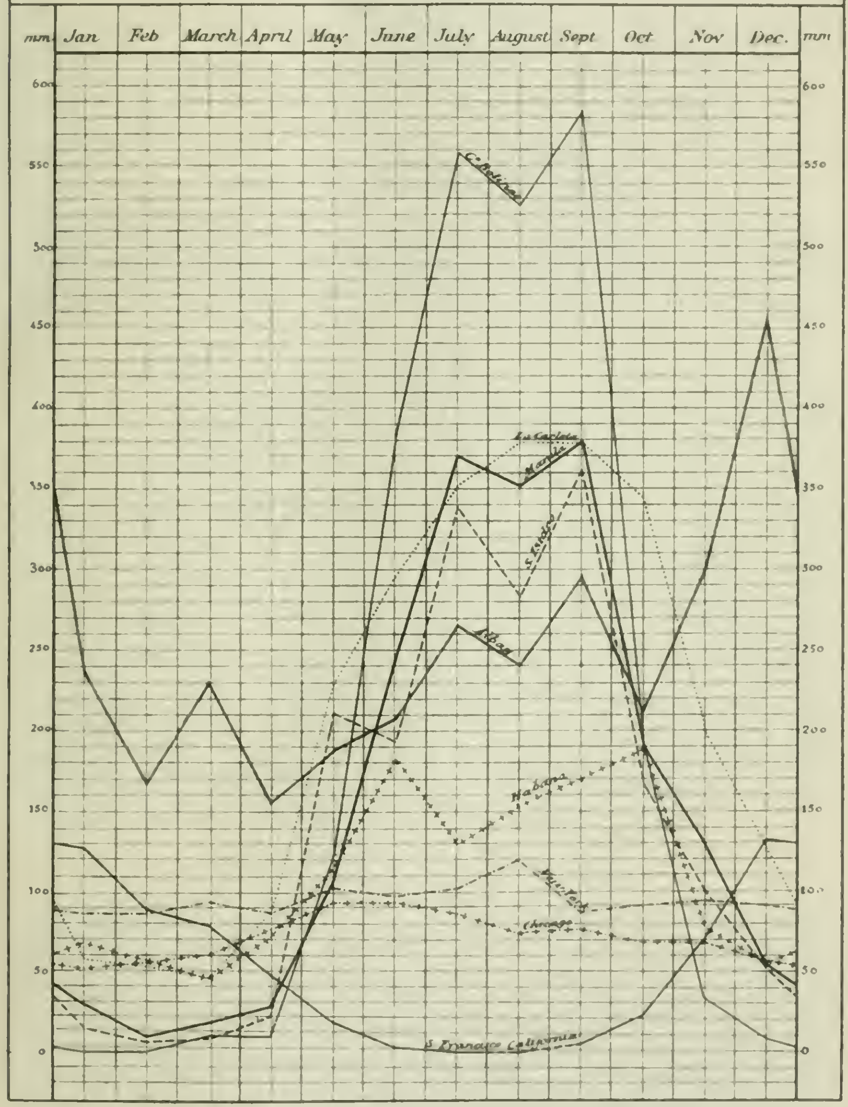
GRAPHIC REPRESENTATION OF THE AVERAGES OF PRECIPITATION OF WATER IN SEVERAL POINTS OF THE PHILIPPINE ARCHIPELAGO, THE ANTILLES, AND THE UNITED STATES OF AMERICA.

Let us close this account of the rainfall in Manila with Engraving XXXIII, which represents by way of curved lines the yearly variation of rainfall in distinctive station of the archipelago, Habana, and some points in the United States; for instance, San Francisco, Cal. (occidental coast), Chicago (interior), and New York (oriental coast). It will immediately be seen that the most abundant yearly precipitation of water in the Philippines may be compared with the yearly precipitation of the points which we have just named.

The yearly variation of rainfall of San Francisco, Cal., is inverse to that of Manila, because when there is no precipitation of water in California at the same time in Manila it is most abundant and extraordinary.

PLATE XXXIV.

Annual variation of the rain in different places of the Philippine Archipelago, of the Antilles and of the United States of America



CHAPTER VI.

WINDS.

I.—MONTHLY FREQUENCY OF THE WINDS IN MANILA.

METHODS WE HAVE FOLLOWED IN ASCERTAINING THE MONTHLY FREQUENCY OF WINDS IN MANILA.

The study of the monthly frequency or repetition of the winds is, no doubt, one of the most important in determining the climate of countries and the changes it undergoes in the course of a year. For this reason, and desirous that this work shall be most complete, we have not deemed it wise to include or give the same total of results which we might have obtained from the drawings of the "frequency of winds" ("frequentia de vientos"), published in our monthly bulletin, for the reason that it contains but the eight principal points of the compass or direction of the winds. In order to include sixteen directions, we have had access to the original records, and beginning with the year 1887 to 1898, inclusive,[1] we have formulated, noting month by month and year by year, every time the same direction has been repeated. In preparing these records or statistics we have found that on some days, by reason of the clock stopping or other similar reason, the observations of two or more hours were wanting, and these days we have omitted in order that they may be made more complete and satisfactory. The number of days omitted is seventeen; four in the month of December, 1895; four in the month of April; one in the month of September, 1896, and eight in the month of August, 1898. Those most important to examine and remember are those of the last column of the Table LXXX, where we give the total number of observations in each month and the sum total for twelve years.

OBJECT OR PURPOSE OF TABLE LXXX.

Having made these brief observations, which we have deemed necessary, let us proceed to give in Table LXXX the total obtained for each month in the 16 directions or points of the compass by means of the records mentioned, adding to each sum the corresponding per cent. Most important deductions can be obtained from this table, worthy of special attention and study. In order to proceed with some degree of method, we will simply dwell here on the monthly frequency or repetition of the winds, leaving for the next paragraph their annual and semiannual frequency, as shown in the aforesaid table.

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[1] For the lack of time we have omitted several years prior to 1887

TABLE LXXX.—*Monthly, annual, and semiannual frequency of the winds in Manila, 1887–1898.*

Month.	N.		NNE.		NE.		ENE.		E.		ESE.	
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.
January	1,053	11.8	954	10.7	848	9.5	517	5.8	887	9.9	497	5.6
February	515	6.3	446	5.5	627	7.7	527	6.5	1,197	14.7	795	9.8
March	400	4.5	414	4.6	578	6.5	594	6.7	1,432	16.0	1,022	11.4
April	252	2.9	248	2.9	351	4.1	454	5.3	1,211	14.2	1,142	13.4
May	398	4.5	391	4.4	453	5.1	294	3.3	721	8.1	620	6.9
June	354	4.1	367	4.2	478	5.5	300	3.5	606	7.0	473	5.5
July	348	3.9	281	3.1	309	3.5	240	2.7	369	4.1	268	3.0
August	297	3.4	243	2.8	385	4.4	197	2.3	334	3.8	251	2.9
September	330	3.8	291	3.4	307	3.6	203	2.4	343	4.0	239	2.8
October	562	6.3	664	7.4	615	6.9	322	3.6	516	5.8	330	3.7
November	984	11.4	899	10.4	833	9.6	404	4.7	551	6.4	290	3.4
December	1,314	14.9	1,168	13.2	902	10.2	369	4.2	593	6.7	314	3.6
Annual	6,807	6.5	6,366	6.1	6,686	6.4	4,421	4.2	8,760	8.4	6,241	6.0
November and May	4,916	8.0	4,520	7.4	4,592	7.5	3,159	5.2	6,592	10.8	4,680	7.7
June and October	1,891	4.3	1,846	4.2	2,094	4.8	1,262	2.9	2,168	4.9	1,561	3.6

Month.	SE.		SSE.		S.		SSW.		SW.		WSW.	
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.
January	341	3.8	124	1.4	114	1.3	158	1.8	358	4.0	457	5.1
February	591	7.3	184	2.3	103	1.3	141	1.7	328	4.0	483	5.9
March	741	8.3	284	3.2	125	1.4	154	1.7	385	4.2	506	5.7
April	996	11.7	334	3.9	142	1.7	188	2.2	430	5.0	471	5.5
May	637	7.1	301	3.4	296	3.3	413	4.6	872	9.8	743	8.3
June	529	6.1	294	3.4	411	4.8	534	6.2	1,027	11.9	680	7.9
July	373	4.2	316	3.5	463	5.2	907	10.2	1,719	19.3	778	8.7
August	224	2.6	221	2.5	461	5.3	892	10.2	1,712	19.6	1,008	11.5
September	257	3.0	269	3.1	466	5.4	833	9 7	1,700	19.7	910	10.6
October	328	3.7	243	2.7	300	3.4	465	5.2	729	8.2	656	7.3
November	244	2.8	141	1.6	147	1.7	194	2.2	342	4.1	378	4.4
December	159	1.8	93	1.1	100	1.1	151	1.7	258	2.9	376	4.3
Annual	5,420	5.2	2,804	2.7	3,128	3.0	5,030	4.8	9,860	9.4	7,446	7.1
November and May	3,709	6.1	1,461	2.4	1,027	1.7	1,399	2.3	2,973	4.9	3,414	5.6
June and October	1,711	3.9	1,343	3.1	2,101	4.8	3,631	8.3	6,887	15.7	4,032	9.2

Month.	W.		WNW.		NW.		NNW.		Calm.		Total observations.
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	
January	410	4.6	161	1.8	151	1.7	185	2.1	1,713	19.2	8,928
February	431	5.3	184	2.3	99	1.2	88	1.1	1,397	17.2	8,136
March	451	5.1	149	1.7	90	1.0	108	1.2	1,495	16.6	8,928
April	471	5.5	182	2.1	84	1.0	69	0.8	1,519	17.8	8,544
May	534	6.0	169	1.9	96	1.1	120	1.3	1,870	20.9	8,928
June	409	4.7	180	2.1	142	1.6	90	1.0	1,766	20.4	8,640
July	445	5.0	211	2.4	173	1.9	119	1.3	1,609	18.0	8,928
August	412	4.7	194	2.2	151	1.7	139	1.6	1,615	18.5	8,736
September	437	5.1	188	2.2	148	1.7	132	1.5	1,563	18.1	8,616
October	421	4.7	200	2.2	142	1.6	171	1.9	2,264	25.4	8,928
November	343	4.0	162	1.9	183	2.1	237	2.7	2,308	26.7	8,640
December	311	3.5	153	1.7	169	1.9	247	2.8	2,155	24.4	8,832
Annual	5,075	4.8	2,133	2.0	1,628	1.6	1,705	1.6	21,274	20.3	104,784
November and May	2,951	4.8	1,130	1.9	872	1.4	1,054	1.7	12,457	20.4	60,936
June and October	2,124	4.8	973	2.2	756	1.7	651	1.5	8,817	20.1	43,848

WINDS OF MAXIMUM AND MINIMUM FREQUENCY IN THE DIFFERENT MONTHS OF THE YEAR.

In the following summary will be seen the maximum and minimum frequency or repetition of the winds in the different months of the year, as shown by a simple glance at Table LXXX:

Month.	Frequency.		Month.	Frequency.	
	Maximum.	Minimum.		Maximum.	Minimum.
January	N.	S.	July	SW.	NNW.
February	E.	NNW.	August	SW.	NNW.
March	E.	NW.	September	SW.	NNW.
April	E.	NNW.	October	SW.	NW.
May	SW.	NW.	November	N	SSE.
June	SW.	NNW.	December	N.	SSE. and S.

So that the prevailing wind in Manila is from the southwest from May until October; that is to say, for about six months. From November to January north winds prevail, and during the other three months, February, March, and April, the easterly winds prevail. The same frequency of the north and northwest winds occurs in February and October, and that of the south and south-southeast winds in the months of November, December, and January.

Table LXXX shows the months in which the north wind has the greatest per cent and those in which the north-northeast and northeast winds prevail mostly after that, and also the months in which the east winds are most prevalent, after the maximum frequency of the east-southeast and southeast, if we leave out the month of February, which gives the northeast wind a larger per cent than that from the southeast. Accordingly it can be said that in the months of January, February, and April the east and southeast winds prevail, both inclusive.

As to the months in which the southwest winds prevail, it is to be seen that May and October are not below the maximum frequency of east and north-northeast winds, from which it appears that May is the month of the veering of the winds from east to those of southwest, and that October is the month wherein they change from southwest to those of the north.

MONTHLY MEDIUM OR RESULTANT DIRECTION.

Applying Lambert's complete form and substituting each of the 16 directions instead of the corresponding per cent the table gives us, we will have found the medium or resultant directions for each of the twelve months in the year, as follows:

Month.	Resultant.	Month.	Resultant.
January	N. 41° 07′ E.	July	S. 34° 28′ W.
February	N. 83° 13′ E.	August	S. 40° 48′ W.
March	S. 84° 18′ E.	September	S. 39° 41′ W.
April	S. 63° 31′ E.	October	S. 75° 32′ E.
May	S. 16° 55′ E.	November	N. 27° 45′ E.
June	S. 0° 11′ E.	December	N. 21° 13′ E.

II.—ANNUAL AND SEMIANNUAL RÉGIME OF THE WINDS OF MANILA

ANNUAL FREQUENCY OF THE WINDS IN MANILA.

From the annual sums or totals and the corresponding percentage which we have given in Table LXXX the annual régime of the winds can be deduced, which is herewith graphically represented in the drawing or figure (1).

These facts show that the most prevailing winds during the year are those from the southwest, followed by those from the east. The frequency or prevalence of those from the other directions diminish in the following order: West southwest, north, northeast, north northeast, east southeast, southeast, south southwest, west, east northeast, south, south southeast, west northwest, northwest, and north northwest.

PREVALENCE OF THE WINDS IN MANILA DURING THE TWO SEASONS NOVEMBER TO MAY AND JUNE TO OCTOBER.

We have divided the year into two periods, from November to May and from June to October, and we have added to Table LXXX the corresponding facts which have helped us to give in the two following drawings, 2 A and 3 A, the annual régime of the winds in Manila. During the period from June to October those from the southwest are most prevalent, those from the east and north having the maximum prevalence in the other period.

Annual medium or resultant direction	S. 58° 42′ E.
Medium semiannual direction—	
June to October	S. 32° 41′ W.
November to May	N. 70° 30′ E.

ARE THE PARTICULAR WINDS OF THE PHILIPPINE ISLANDS MONSOONS IN THE PROPER SENSE OF THE WORD?

This is a question which naturally suggests itself to us after treating of the monthly prevalence and annual and semiannual régimes of the winds in the Philippines. As Father Algué has treated this subject in a masterly manner in Chapter IV of the second volume, page 179, of the work Philippino Cyclones, we will simply quote his ideas, proving them as we pass with certain more recent facts which we gathered in our meteorological researches of 1897. Yet, to a great degree, we will have to take for granted the meaning of normal, general, and particular winds.

WHAT IS UNDERSTOOD BY NORMAL, GENERAL, AND PARTICULAR WINDS.

According to Father Algué, there are certain winds which can be called or termed general, or eastern or tropical winds; those dependent on the difference of temperature between the polar and equatorial regions; others, particular or local winds, dependent on certain thermic conditions between the continent and the seas or between the islands and contiguous seas. If the differences exist for a long period of time they are termed or called monsoons. If the differences obey the daily thermic changes they are called breezes from the sea or breezes from the mountains; that is to say, there is no essential difference

ANNUAL PROGRESSION OF THE WINDS AT MANILA.

5 mm. = 1%.

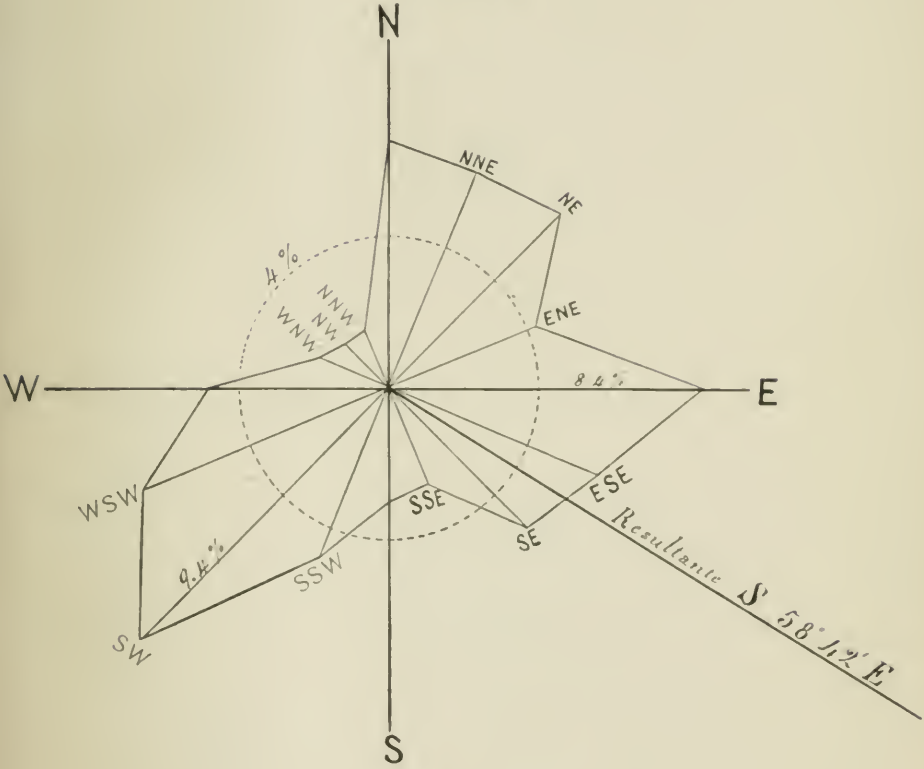
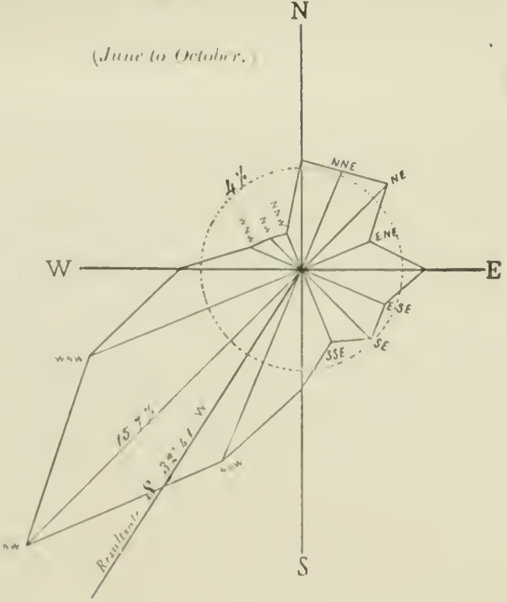


Fig. 15.

SEMIANNUAL PROGRESSION OF THE WINDS AT MANILA.

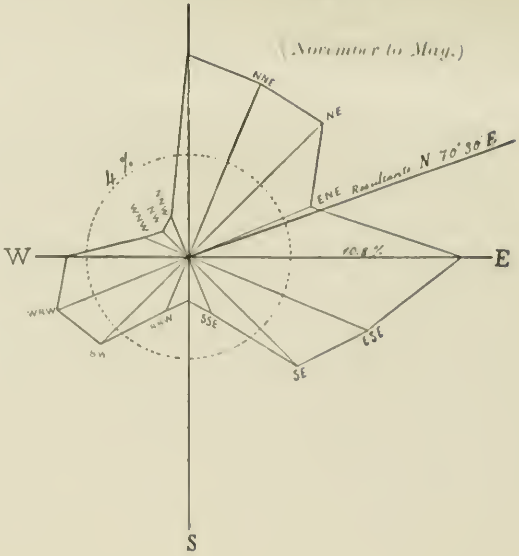
5 mm = 1%

Figª 2ª



(June to October.)

Figª 3ª



(November to May.)

between breezes and monsoons, since both winds are essentially dependent on the geographical, geodetical, and, to a certain extent, the topographical distances of the regions, and only differ in the duration of their period, or whether coming from a greater or lesser distance. From what precedes, it follows that the essential difference between general or tropical winds and monsoons lies in the fact that the general winds depend on the normal changes of temperature corresponding to the latitude, while the monsoons depend, not on the normal changes of temperature in themselves, but on the changes of these and on other particular causes more or less independent of the latitude, such as elevations and depressions of ground, large or small continents and seas, or extensive sea, etc. It can well happen that in determined circumstances general winds and monsoons may contribute to give to the winds the same course, or can modify themselves to different results (resultantes).

The winds from north and east, prevailing in the Philippines certain months in the year, can only be improperly termed monsoons from the northeast.

Now that these preliminaries are laid down, it is known that, according to the theory of atmospheric circulation, the normal and general or tropical winds would be all the year round from the north, by reason of the rotation of the earth from the northeast, in the zones and seas comprised in our archipelago, and, in general, in all the seas and intertropical countries in the Northern Hemisphere.[1] Nevertheless, it does not so happen in the archipelago and adjacent seas, thus pointing out the existence here of some particular cause which modifies or changes its normal direction. For example, taking the medium change of the atmosphere in the archipelago, the change observed in Manila, situated in the intervening latitude, the highest degree of Manila, including the Bataeñs Islands, it is to be observed by the preceding paragraph that the maximum frequency pertains to the north and northeast winds, the most prevalent being those from east to southeast.

This granted, the winds being from the northeast normal or tropical, they could not be properly called monsoons coming from the northeast. In the months of November to March the thermic conditions are so changeable in the archipelago and the immense Asiatic Continent, the inland of which is very cold, that there exist certain currents from north to south, leaning more to the east, so to speak, by the rotation of the earth—currents which reenforce the normal currents in the same direction as that of the tropical winds, making the northeasters very hard in those months, as they are felt on the high seas and on the eastern coast of the island. Solely on this ground could the currents or tropical winds from northeast be called monsoons.[2]

We will not pay much attention to the winds comprised between east and southeast, which are the prevailing ones in Manila during February, March, and April, partly because the authors who admit of the presence of monsoons in the Philippines at times only mention the monsoons from northeast and from southwest, partly because in other places in the archipelago they do not go close to the second quadrant, as they do in Manila, but are more or less comprised in those from northeast in March and April, as can be gathered from the observations at Albay, Aparri, and Iloilo, which we will mention hereafter, and in part because this inclination, more or less marked, toward the east, east-southeast or southeast might be due to the prevailing normal or tropical winds of the Southern Hemisphere coming in contact with the wind currents of the Northern Hemisphere, which become weakened as the temperature of the Asiatic Continent increases and the continents of Borneo and Australia become colder.

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[1] See The Winds of the Globe, by Coffin, p. 665.

[2] See the excellent work, Memoirs on the Winds and Monsoons of the Arabian Sea and North Indian Ocean, by Dallas. Calcutta, 1887. Page 29.

The southwest winds prevailing in the Philippines in the months of June to September are not monsoons in the real sense of the term. It is difficult to determine whether the winds from the southwest, which we have seen prevail in the months of June to September, should properly be called monsoons. This is a delicate subject, especially when both ancient and modern writers assert that there exists in the Philippines and south of the China Sea the monsoon from the southwest. For this reason we shall reply with the least apprehension, basing our reply on verified facts, and giving the results of our investigations only that credit which they themselves deserve and bear out, as in the case of any other physical theme.

The question can be framed on the following form: Are the southwest winds which prevail in the archipelago and in the China Sea (partly tropical) during certain periods of the year, in the scientific sense of the word, monsoons? In our humble way of thinking they are not monsoons in the proper sense of the word, but currents due to corresponding cyclonic vortices, or due to abnormal changes in the atmosphere.

The frequency and force of such currents being a fact, it might lead to the existence of a cyclonic vortex or some atmospheric disturbance, and consequently the question is not a matter of name, but something more important, in order that we may try to prove our assertion with due ease.

The writers who in some way or another have dwelt on this question suppose that the beginning of the southwest monsoon is sometime in the month of May, so that according to their views, said monsoon prevails in the month of June. The constant and attentive experience of many years shows that this is not the case in Manila and near-by seas. In order to prove this it will only be necessary to cite several meteorological paragraphs of observations corresponding to the month of June for several years back.

We read in the review of June, 1890:

> What is strange is the prevailing winds from the second quadrant in the period (according to the opinion of some) of that of the southwest monsoon. Bearing in mind the observations above set forth, it is an argument of great importance in meteorology in general which ought not to be passed by without treating of the atmospheric currents.

The review of the month of June, 1892, says:

> Though in the season of the monsoon of the southwest, the currents of the second quadrant prevail in the month of June, not only with respect to the lower but to the higher winds. This was fully explained by the observation of the two principal atmospheric disturbances taking place in Luzon, which had their center of minimum pressure toward the Indian Ocean. When the disturbing center, during the first squall, was in the north of Luzon the winds of the third quadrant became general.

The meteorological review of the month of June, 1893, begins this way:

> The meteorological state or nature of the month of June proves once more that the change of the monsoon does not take place in this archipelago with the almost mathe-

> matical precision told us by many writers. In fact, after the depressions which crossed this island in the month of March, the currents from the second and third quadrant prevailed with as much regularity as if we were in the month of April.

The review of June, 1894, says:

> From the study of the directions of the superficial currents and inferior or lower clouds we find an important result; that is, that in the month of June the currents from the third quadrant originate or take place more in the abnormal conditions of the atmosphere than in the normal. We will confine ourselves to the month of June in the years 1890, 1891, 1892, 1893, and 1894. The month of June, 1890, was a month of little atmospheric agitation, so that the extent of the minimum of the month did not go below 755.17 mm.; nevertheless, through influences of distant depressions, the barometer was low during the first days of the month—that is to say, from the 2d to the 5th, from the 13th to the 15th, and from the 22d to the 25th. There were the only days in which the winds of the third quadrant prevailed. During the rest of the days not only the direction of the clouds but that of the winds was from the second quadrant.
>
> Just the opposite was the month of June, 1891, being full of atmospheric agitation or changes—not intense or great agitation, nor did the barometer go below 755 mm., but persistent to such a degree as to cause the barometer to drop from the 6th to the 17th and from the 20th to the last of the month. The winds of the third quadrant prevailed during all these days, Lambert's formula giving us the resultant direction of winds southwest, and the prevailing direction of the clouds west-southwest. During the 6th, 10th, 12th of June, 1892, the winds blew from the third quadrant on days of atmospheric disturbances, the barometer reaching 752.91 mm. We do not mean to say by this that in case of atmospheric disturbances the southwest winds alone blow; it is understood that if the cyclonic center forms near the south of Manila, or cross the southerly region of the archipelago, it must follow that the winds prevailing in Manila are those from the first and second quadrants. This happened exactly in the month of June, 1892 and 1893, when the resultant of both the currents and lower clouds were from the first quadrant, on account of small cyclones in the Tolo Sea and the China Sea.
>
> As to the present month of June, the currents from the third quadrant prevailed; that is to say, a cyclonic center was being developed to the north-northwest of Manila, and another ran by the Pacific, as will be seen later on in treating of atmospheric disturbances. The facts above mentioned not only confirm what was said in the review of June, 1892, and more so that of 1893, but also give us ground to suspect whether they are a basis for us to properly count or embody the month of June among those months where the monsoon from the southwest prevails.

In the review of June, 1897, we said:

> If in the table of "extreme equivalents" of this bulletin we give attention to the medium which results for the relative prevalence of the winds, we shall see that the major medium corresponds to the winds from the third quadrant. If we examine separately each decade, we will find that, in the first, two from the east prevail, generally of the second quadrant, and that only in the third decade those of the southwest or third quadrant prevail, due to various depressions running along the north quadrants. If on the 4th, 5th, 6th, and 12th of the month the winds of the third quadrant blew, it is to be noted that they coincided in the path of two depressions which in those days ran through high parallels, as can be seen on the daily maps at the observatory of Tokio, and blowing only a certain hour, being the breeze (brisa) which blows here in Manila and from the third quadrant.
>
> This is another proof of an idea several times given in our bulletins; that is to say, that at least not in the month of June does the monsoon from the southwest, in the correct sense of the word, prevail. If at any time the wind of this name prevails in these parts it is not the real monsoon, but something similar, due to the atmospheric disturbances, more or less near, that develop or cross the north quadrants.

In view of this large amount of testimony, founded on fact and well studied and understood, there seems to be little room to doubt that the wind sthat blow in the Philippine Archipelago in June are not the real monsoon, but are due to atmospheric disturbances. From what we have said we can only conclude that the southwest monsoon in the Philippines is retarded and does not prevail in the month of June, because of the prevalence, even in that month, of the tropical winds of the southeast.

From the tables of meteorological extreme equivalents published by the observatory in their monthly bulletins of the aforesaid month from 1890 to 1898 (omitting the winds from west, west-southwest, and southwest south-southwest) during those days when the archipelago was evidently under the influence of some cyclonic vortex, it will be easy to calculate the prevailing currents of air in normal weather. Note that the breeze (brisa) or southwest winds is still included, being from that quarter in Manila.

The results of the above-mentioned study of comparisons we publish in the following table, in which the sum totals of the prevailing winds and calms vary by reason of the omission of certain winds.

Prevailing winds in Manila during the month of July.

[The cyclonic winds of the third quadrant are eliminated.]

Year.	N. NNW.	NW. WNW.	SW. SSW.	W. WSW.	S. SSE.	SE. ESE.	E. ENE.	NE. NNE.	Calms.
1890	1.7	1.5	0.9	0.3	1.6	0.9	1.5	1.3	3.7
1891	1.0	1.1	0.6	0.4	4.4	1.4	1.1	0.5	3.9
1892	1.4	0.6	0.7	0.5	3.1	1.6	3.1	1.7	2.3
1893	2.0	1.5	1.0	1.3	1.5	1.5	2.2	3.2	1.9
1894	1.3	1.4	0.7	1.3	2.5	1.2	1.4	2.2	4.2
1895	0.8	0.6	0.8	1.1	1.8	0.9	0.9	1.7	6.3
1896	1.5	1.9	0.8	1.0	2.5	2.7	1.1	1.8	3.3
1897	0.8	0.7	1.3	1.3	1.9	2.6	1.8	1.8	6.3
1898	0.5	0.7	0.8	1.0	1.6	2.5	2.1	0.7	9.8
Total	11.0	10.0	7.6	8.2	20.9	15.3	14.1	14.9	41.7
Mean	1.2	1.1	0.8	0.9	2.3	1.7	1.6	1.7	4.6

From the medium equivalents of the foregoing table it can be seen that the prevailing winds in Manila in normal weather are of the second quadrant or tropical winds of the Southern Hemisphere.

Accordingly, the southwest winds of July are not, scientifically speaking, monsoons.[1] A like study could be made from the meteorological data of the months of August and September giving identical results. The prior argument acquires still more force when we consider that from time immemorial the tribe of Indians found in the western parts of Luzon took advantage of the month of August to set sail with their boats to various southern points, as the "prevail wind" (as they used to call it in their tongue) was the small monsoon or winds from the first quadrant and sometimes of the second, that is to say, easterly winds. Because it is true that during the month of August the atmospheric depressions are less, and the winds from the third quadrant are less prevalent, which, if they had been real monsoons from the China seas, would not have given rise to such persistent popular belief.

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[1] Remember what we said in the affirmative as to the foregoing in the Meteorological Review of the month of July, 1897.

In the observations made in the present month of July we find a very convincing proof of the opinion we have so often given in our publications, that the southwest winds in the months of July, August, and September in the Philippines are not real monsoons, inasmuch as they only predominate when we feel some atmospheric depressions that run along the northern quadrant. Look at the table of equivalent extremes and it will be seen at a glance that during the whole month the prevailing winds were from the third quarter from the 1st to the 5th, the 17th to the 18th, and from the 23d to the last of the month; yet from the 1st to the 5th there existed in the archipelago a depression from the month before, drifting northerly; and from the 23d to the last of the month it will be seen, from what we shall say later, that we were under the influences of depressions, also drifting along the northern quadrant; and, lastly, during the 17th and 18th of the month there was in high parallels in Japan a center of low pressure, the extreme of which almost reached to the extreme northern point of the island of Formosa, as can be seen from the daily maps published by the central observatory of Tokyo. We have to confess that, after having suspected the existence of this cyclonic center merely by observing that the winds of the third quadrant continued to blow in Manila outside the accustomed hours, we felt a real satisfaction in finding our suspicions fully confirmed by reference to the tables referred to. During the rest of the month the southwest winds have blown on certain few occasions, and only at the time of the brisa, which here in Manila blows from that quarter.

What we have said is sufficient to confirm our position, all the more so because, according to the opinion of those who have dealt with monsoons, it is during the month of July that they are most encountered in the whole zone of our archipelago.

If the winds of the third quadrant in the Philippines and the China Sea were real monsoons,[1] that is to say, a wind coming at regular times and regular in force, caused by a general unbalancing of the atmosphere, but distinct from that which originates the tropical winds, there is no reason that there should be any difficulty in explaining why they prevail in such a small area, as in the lower part of the China Sea and in the archipelago.

In neither the western Carolinas, for example, nor in the islands of Batanes, nor on the coast of China, nor in the canals of Bachi and Balintang, from the parallel 20° and other localities and contiguous seas that are in similar physical conditions to our archipelago, do the winds of the third quadrant prevail, but only easterly winds.[2] Nor should it be said that the southwest monsoon in the Philippines and the China Sea is the cause of the real monsoon of the Indian Ocean, because, were this so, the real monsoon should prevail in the lands and seas lying between, but neither in the westerly ones north of Borneo and contiguous seas nor in Sumatra do the winds of the third quarter prevail, but those from the south, or tropical winds.

As in good logic it can not be admitted that the winds of the third quadrant, which prevail in the Philippines in the months of July, August, and September, are monsoons in the correct sense of the term, but are winds of depression, to what frequent atmospheric changes and disturbances must our archipelago be exposed south of the China Sea that such winds should prevail during so many months? From a careful study of the trajectories (or planes) of real Philippine cyclones in the months of July, August, and September we can say: First, that when their vortices enter into the archipelago they occupy at least the parallel 12° N.; and the influence of the cyclone at regular distances from its entering the archipelago until its disappearance in the continent keeps in commotion for several days all points south of the China Sea and the greater portion of the archipelago, drawing toward it the currents from the third quadrant.

Second. The following is worthy of note: During the months of July, August, and September many of the cyclones whirl around to the east of the Straits of Baschi and Baligegtan, or of the island of Formosa, as well as to the west of the Batanes Islands, or the Formosa

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[1] The word monsoon (manzón) comes from *mancine*, Arabic, which means "season" or part of the year.

[2] The Winds of Globe, by Coffin; Discussion and Analysis of Winds, by Wyckoff, p. 735.

Strait, whence they exert their influence on the whole of the archipelago and the south of the China Sea often for many days, being often slow in their returning course. We know of cases where it has taken the vortex of the cyclone five days to revolve or recurve. On the other hand, when the cyclones follow tracts much inclined to the north, after they have returned they exert their influence in the lower latitudes again for many successive days, so that it results not infrequently that the influence of a single typhoon is felt for the space of twelve, fourteen, or more days.

If we further allege that oftentimes these cyclones follow each other closely, four or five days apart, during the months of July, August, and September, it can be possible that the southwesters prevail for many days in those localities.

Besides, it often happens, and singularly, too, that in the months of June and July there develop in the northwest, north, and north-northeast of Luzon centers of minimum pressure so slowly that they appear to remain stationary for many days, followed, as is natural, by continuous currents and showers of rain from the third quadrants, known by the native-born residents as "collas," which we will have occasion to describe in Chapter VIII.

We will close this proof with a further suggestion. Our experience teaches us that in Manila (and the same happens, no doubt, in the China Sea) the winds of the third quadrants are so ahead of time on the approach of a cyclonic vortex to the east of Luzon, in the Pacific, that not only there is a complete convergence, but also it is not rare to have the southwest winds prevail when the vortex is directly east of the observer.

On the other hand, it is a fact that the advance of the southwesters in Manila is greater when the angle formed by the trajectory and parallel are greater, measuring the angle from east to west, on the north. This angle increases in April, May, June, July, and August, and consequently during these months with more frequency and prevalence the southwesters advance. This being so, what is the cause of such peculiar phenomena? We judge it is nothing more than the tropical winds from the southeast, which are the normal winds of April, May, and June, and probably those of July and August.

In effect, the cyclonic vortex being to the east of the observer, there ought to be winds from the fourth quadrant, though slight; and even though the cyclone is at a moderate distance (and this does not take place, as shown by experience), it is hard to admit a general cause which drifts the winds to the third quadrant, and this cause seems to be none else than the tropical winds from southeast which may be confused with those of the fourth quadrant, giving always results of the third quadrant as observed; and being of light force, readily explains why they exert a very slight influence on the cyclonic winds.

III.—HOURLY PREVALENCE OF THE WINDS IN MANILA.

HOURLY MONTHLY FREQUENCY.

After having treated, in the two prior paragraphs, of the monthly and annual frequency of the winds in Manila, we will devote ourselves here to the hourly frequency, studying, before all, the medium hourly prevalence or frequency in each month, and thereafter the medium hourly annual frequency. For the first step we have formulated Table LXXXI, in which we give, hour by hour, the number of times each of the sixteen principal directions of the wind is found in the records of this observatory from 1892–1898. Bear in mind that in this work and some of the former works we have omitted some days, wherein some hour of observation is lacking, as we have hereinbefore mentioned.

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898.*

JANUARY.

Direction.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 m.
N.	35	34	35	39	38	38	39	30	37	19	8	10
NNE.	25	12	36	39	36	32	24	40	35	13	17	11
NE.	28	26	27	34	38	36	32	36	26	19	17	15
ENE.	11	9	17	19	20	17	16	11	11	7	5	8
E.	14	11	10	9	9	9	8	7	11	11	2	8
ESE.	12	9	5	4	6	2	2	2	...	2	5	6
SE.	8	5	1	5	1	1	1	...	6	...	2	4
SSE.	3	3	1	2	...	...	...	...	1	...	...	...
S.	1	1	...	...	...	...	...	...	3	5	8	7
SSW.	...	...	...	...	...	...	...	...	3	6	11	8
SW.	...	...	...	...	...	...	...	...	5	18	11	21
WSW.	1	...	...	...	...	...	...	...	6	26	28	36
W.	3	2	1	1	...	...	1	...	7	11	34	18
WNW.	2	3	...	...	...	...	...	...	8	12	20	16
NW.	1	1	2	3	1	...	1	2	5	11	11	12
NNW.	3	5	7	5	2	6	7	8	13	11	6	2
Calm.	70	66	72	57	66	76	86	78	10	16	2	5

Direction.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.	9 p.m.	10 p.m.	11 p.m.	12 p.m.
N.	7	5	4	7	7	13	9	13	14	18	23	28
NNE.	10	12	16	12	15	19	16	14	8	15	18	22
NE.	16	15	8	21	16	20	19	15	17	11	8	25
ENE.	11	10	14	11	22	15	11	15	17	8	10	11
E.	7	20	24	26	36	38	59	44	35	31	27	17
ESE.	10	8	12	21	27	41	33	67	31	32	25	17
SE.	4	8	20	22	26	22	22	15	22	17	12	13
SSE.	7	5	5	9	8	3	1	7	5	3	6	3
S.	7	9	6	8	8	3	2	3	1	3	...	1
SSW.	9	13	10	5	3	2	...	3	5	1	...	1
SW.	21	19	17	6	6	7	5	2	2	...	...	1
WSW.	41	41	37	33	11	...	3	2	1	...	...	1
W.	36	30	22	10	1	2	...	...	1	1	...	...
WNW.	13	9	4	6	4	1	...	...	...	...	1	1
NW.	9	7	4	4	3	...	1	1	...	1	5	2
NNW.	3	1	1	1	1	1	1	...	2	4	3	5
Calm.	6	5	13	9	23	30	35	16	53	72	79	69

FEBRUARY.

Direction.	1 a.m.	2 a.m.	3 a.m.	4 a.m.	5 a.m.	6 a.m.	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 m.
N.	17	11	16	21	25	21	24	22	17	6	1	1
NNE.	14	12	22	25	16	21	21	17	17	4	2	1
NE.	13	21	20	22	26	25	27	26	12	7	2	5
ENE.	6	12	20	19	20	20	16	18	9	6	7	5
E.	23	23	15	10	7	10	11	8	8	12	9	13
ESE.	13	9	9	8	8	5	4	1	5	7	8	9
SE.	18	12	6	5	2	1	...	1	6	3	4	5
SSE.	2	1	2	1	1	...	...	...	3	1	5	3
S.	2	1	1	1	...	...	...	...	4	2	4	10
SSW.	1	1	1	1	...	...	1	1	10	9	5	5
SW.	1	1	...	...	1	1	...	...	7	22	23	33
WSW.	...	...	1	1	...	...	...	1	21	32	47	43
W.	...	...	...	...	...	...	...	4	20	57	41	16
WNW.	2	...	...	1	1	...	3	...	11	15	26	13
NW.	1	3	3	...	3	5	1	2	5	6	9	3
NNW.	5	7	4	4	2	2	...	1	4	3	2	1
Calm.	80	81	78	79	86	87	90	93	39	6	1	2

Table LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

FEBRUARY—Continued.

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	2	2	4	3	5	5	....	3	6	9	8	13
NNE.	....	3	1	2	2	1	3	3	1	1	5	5
NE.	4	5	8	12	6	10	10	6	4	7	11	10
ENE.	5	4	4	11	18	15	7	9	7	10	12	10
E.	12	17	21	20	31	48	64	74	55	43	44	32
ESE.	19	22	25	38	49	45	53	39	33	39	25	21
SE.	6	13	24	37	34	40	27	29	44	34	33	26
SSE.	5	9	16	23	15	13	5	2	4	4	3	3
S.	7	7	4	9	3	1	3	2	3	5	....	1
SSW.	12	8	11	1	3	1	2	2	3	1	1	....
SW.	18	24	19	8	5	7	5	4	3	1	....	....
WSW.	51	39	32	17	10	1	2	1	....	....	1	2
W.	41	26	15	8	4	....	....	....	....	....	3	....
WNW.	13	12	7	....	2	1	1	1	1	....	2	....
NW.	2	4	2	4	1	1	....	....	....	2	2	3
NNW.	....	....	....	1	....	....	....	....	1	....	2	4
Calm.	1	3	5	4	10	9	16	23	33	42	46	68

MARCH.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	12	16	19	16	23	12	19	20	11	4	3	1
NNE.	4	6	17	23	10	12	17	19	12	4	3	4
NE.	17	27	29	30	22	16	21	21	9	6	3	4
ENE.	15	17	14	10	24	19	13	10	14	8	11	10
E.	20	25	13	15	17	21	17	17	7	15	8	14
ESE.	32	27	19	14	10	18	13	7	12	9	13	12
SE.	21	11	9	4	2	2	....	....	7	6	8	12
SSE.	4	2	....	1	1	....	1	3	1	3	3	5
S.	2	2	....	....	....	....	1	4	9	4	2	3
SSW.	3	1	1	1	1	1	2	1	3	6	5	3
SW.	1	1	....	1	....	....	....	2	16	14	16	29
WSW.	....	....	....	....	....	....	....	....	33	48	51	43
W.	....	....	....	....	....	....	....	4	27	50	58	48
WNW.	....	....	....	....	2	....	....	4	4	19	14	19
NW.	....	....	1	....	1	1	1	2	12	12	12	3
NNW.	1	2	2	4	4	9	....	7	10	4	3	2
Calm.	85	80	93	98	100	106	107	96	30	5	4	5

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	4	3	2	4	2	2	3	1	2	3	6	8
NNE.	4	3	3	4	4	2	4	2	2	5	4	4
NE.	5	12	14	13	17	10	6	6	8	5	9	15
ENE.	10	8	11	19	24	20	16	14	8	7	9	11
E.	20	21	22	31	38	66	67	51	40	35	33	30
ESE.	16	23	28	33	30	42	49	44	46	39	40	41
SE.	18	24	40	46	40	35	27	30	42	41	32	29
SSE.	13	20	20	23	22	11	9	10	9	13	7	7
S.	6	6	5	5	8	1	1	6	4	3	7	3
SSW.	2	6	6	6	2	5	6	5	5	4	4	3
SW.	23	15	16	11	13	11	11	7	5	4	1	....
WSW.	41	36	21	10	5	2	2	1	1	1	1	1
W.	38	22	9	5	3	....	....	....	1	....	....	....
WNW.	11	5	7	....	....	....	....	....	....	....	1	1
NW.	2	2	5	....	1	1	....	....	1	1	....	....
NNW.	3	8	2	4	2	....	....	1	2	3	6	2
Calm.	1	3	6	3	6	9	16	39	41	53	57	62

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

APRIL.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N	7	7	9	12	9	5	6	18	3	....	1	1
NNE.	6	10	10	11	12	13	16	1	5	....	1	....
NE.	6	11	17	21	27	28	15	13	7	4	....	....
ENE.	15	22	20	28	23	25	22	21	5	3	4	1
E.	15	16	21	25	26	19	18	16	16	10	12	11
ESE.	27	17	12	9	5	8	2	13	10	7	9	18
SE.	33	26	14	13	2	1	1	6	10	11	6	13
SSE.	5	6	5	2	....	....	1	5	4	4	5	9
S.	2	2	2	1	....	....	....	5	7	5	5	6
SSW.	1	1	1	....	....	....	....	1	8	6	7	2
SW.	....	....	....	....	....	....	....	7	18	26	20	20
WSW.	....	....	....	....	....	....	....	6	13	38	59	48
W.	....	....	....	....	....	....	....	6	31	40	55	53
WNW.	....	....	....	....	....	....	....	....	12	20	15	20
NW.	2	1	....	....	1	....	....	1	4	7	4	2
NNW	1	....	1	1	1	....	1	1	5	1	....	....
Calm.	86	87	91	83	100	109	121	83	18	1	3	2

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p. m.
N.	0	2	4	3	2	2	1	2	1	2	1	4
NNE.	2	1	1	2	2	3	2	1	....	2	3	7
NE.	....	1	3	5	4	3	1	1	2	4	5	12
ENE.	5	9	12	12	13	15	16	5	5	6	1	8
E.	14	14	16	23	34	47	56	50	34	22	61	23
ESE.	17	13	24	31	31	42	48	56	52	50	17	34
SE.	29	39	42	51	60	39	31	34	50	42	35	39
SSE.	11	21	26	24	12	11	13	13	13	17	8	5
S.	4	11	11	7	3	5	4	5	6	6	3	3
SSW.	4	5	4	4	8	7	13	6	5	2	4	4
SW.	25	15	18	14	16	13	3	8	1	2	1	....
WSW.	42	31	12	12	4	3	3	1	2	1	....	....
W.	31	29	15	8	3	....	1	....	....	....	....	....
WNW.	16	8	7	3	....	....	....	....	....	....	....	....
NW.	1	4	5	3	3	2	....	....	1	2	3	2
NNW.	....	2	3	1	....	....	....	2	3	2	4	4
Calm.	5	1	3	3	11	11	11	22	31	46	60	61

MAY.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	21	19	20	17	17	10	14	14	2	4	1	2
NNE.	18	22	24	23	11	16	12	9	7	3	1	....
NE.	21	17	21	20	21	26	14	15	7	2	3	4
ENE.	5	10	8	17	15	11	19	8	3	4	3	3
E.	15	17	13	14	21	16	18	11	11	6	6	3
ESE.	13	14	11	10	7	10	13	16	13	12	12	6
SE.	18	18	16	14	10	5	8	23	11	14	13	15
SSE.	9	9	7	7	4	6	4	6	7	3	6	8
S.	6	5	4	2	1	1	2	7	12	7	6	6
SSW.	4	2	3	3	....	1	1	7	14	12	8	9
SW.	9	6	5	2	5	3	2	12	31	31	32	34
WSW.	3	7	5	4	1	2	3	5	26	41	52	46
W.	....	1	1	5	....	2	1	5	29	39	40	54
WNW.	1	....	....	....	1	....	1	3	5	10	16	12
NW.	1	2	1	....	....	2	....	4	8	13	6	6
NNW.	4	5	4	1	3	3	3	5	4	2	5	2
Calm.	69	63	74	75	97	103	102	67	27	14	7	7

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

MAY—Continued.

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	4	7	9	5	6	3	4	7	11	15	18	15
NNE.	2	6	4	3	6	6	4	4	6	10	14	19
NE.	3	3	7	16	13	12	7	8	7	10	10	12
ENE.	....	3	3	3	7	6	14	6	6	7	4	3
E.	6	6	8	8	12	13	12	25	18	22	11	16
ESE.	9	9	10	16	8	18	19	17	22	13	23	14
SE.	17	18	20	11	19	17	21	17	20	25	16	18
SSE.	6	6	8	13	9	4	10	12	12	8	10	9
S.	8	7	11	9	13	16	15	18	16	11	11	7
SSW.	9	12	12	17	26	19	20	21	17	9	10	6
SW.	31	40	44	48	42	40	37	25	18	15	8	9
WSW.	57	50	38	33	23	22	11	8	6	6	5	4
W.	42	40	19	8	8	6	2	2	1	3	1	1
WNW.	13	4	11	3	1	1	2	1	2	1	3	....
NW.	3	4	5	3	....	2	1	1	....	2	1	3
NNW.	2	....	1	3	1	....	1	2	3	1	3	3
Calm.	5	2	7	18	23	32	37	43	52	59	69	78

JUNE.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	22	24	26	19	18	7	10	10	7	4	4	2
NNE.	15	15	17	16	12	21	25	5	6	3	1	2
NE.	21	23	21	28	27	24	24	24	12	4	....	....
ENE.	8	13	7	10	6	10	12	6	2	1	3	2
E.	19	9	14	11	14	18	20	19	10	8	9	10
ESE.	13	9	7	11	17	8	8	9	18	19	16	18
SE.	8	8	11	12	11	9	11	16	12	9	14	13
SSE.	8	6	4	4	4	5	8	13	7	6	7	8
S.	9	7	11	9	7	7	7	11	15	10	5	4
SSW.	6	15	10	6	3	4	7	2	16	12	17	12
SW.	13	8	9	8	3	3	4	8	27	43	28	26
WSW.	3	4	5	6	2	....	2	4	13	24	39	50
W.	2	1	1	1	3	3	1	1	19	33	36	35
WNW.	1	2	1	....	....	....	1	3	5	10	17	17
NW.	2	....	....	3	1	1	....	5	5	6	7	5
NNW.	2	3	4	2	1	3	3	4	3	4	2	2
Calm.	58	63	62	64	81	87	67	70	33	14	5	4

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	3	4	4	8	5	3	4	4	11	9	8	10
NNE.	2	3	5	8	13	7	2	6	3	7	4	11
NE.	3	5	5	8	10	9	8	8	6	11	17	21
ENE.	1	7	7	3	5	11	12	6	8	13	7	8
E.	5	8	12	14	14	22	18	24	28	24	23	15
ESE.	22	17	20	12	14	14	13	8	10	15	6	9
SE.	15	15	10	15	21	11	23	21	18	19	18	13
SSE.	3	4	17	7	7	4	7	7	6	6	8	9
S.	6	3	6	10	11	11	13	11	8	7	9	3
SSW.	10	7	11	14	13	14	14	15	9	10	14	13
SW.	32	35	40	30	38	31	27	18	21	15	8	9
WSW.	43	43	35	44	23	28	19	15	8	10	7	6
W.	37	28	18	11	5	1	8	4	5	2	4	3
WNW.	16	13	15	3	2	2	3	4	1	1	1	3
NW.	8	8	7	9	7	3	2	....	1	4	2	....
NNW.	3	....	1	1	2	4	1	3	4	1	2	3
Calm.	1	10	7	13	20	35	36	56	63	56	72	74

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

JULY.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 md.
N.	15	16	16	14	11	13	10	9	3	2	4	3
NNE.	12	14	16	15	11	11	16	14	1	2	2	....
NE.	8	14	13	18	22	14	21	9	5	2	1	2
ENE.	12	14	9	9	10	12	11	8	7	2	3	......
E.	8	4	5	9	18	14	12	17	15	8	2	6
ESE.	5	4	5	8	7	11	7	15	11	8	6	8
SE.	12	13	17	12	10	11	9	9	16	12	10	8
SSE.	11	12	6	11	8	7	7	8	9	6	3	....
S.	6	5	8	9	2	7	7	15	24	15	9	5
SSW.	17	11	15	10	8	9	3	12	16	31	33	21
SW.	20	16	17	12	12	4	9	10	17	37	15	53
WSW.	9	10	7	7	9	8	5	7	20	31	37	50
W.	5	5	3	4	3	3	2	1	17	26	33	39
WNW.	1	1	3	3	2	3	....	2	7	9	12	11
NW.	5	6	8	4	3	1	3	2	10	11	8	4
NNW.	5	5	5	7	2	4	1	3	3	2	2	....
Calm.	66	67	64	65	79	85	94	73	33	13	7	4

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 mn.
N.	5	5	2	3	6	2	5	6	9	10	14	9
NNE.	....	3	5	9	3	5	5	3	8	14	13	12
NE.	....	4	5	4	2	7	5	9	11	12	12	13
ENE.	....	1	3	6	6	6	6	11	9	10	9	8
E.	7	4	6	6	11	17	14	11	12	8	5	7
ESE.	5	5	3	5	8	5	7	3	3	4	6	5
SE.	6	3	6	6	8	8	11	11	10	10	12	12
SSE.	3	4	6	13	9	12	14	11	15	12	13	17
S.	5	9	13	9	10	19	9	15	12	14	14	6
SSW.	24	22	22	25	31	24	25	20	19	21	15	17
SW.	13	50	53	59	54	48	46	30	27	20	23	21
WSW.	57	51	46	34	34	31	18	24	12	11	6	7
W.	35	28	23	13	5	3	7	4	8	6	7	6
WNW.	11	13	7	7	9	5	3	3	2	6	1	2
NW.	6	3	8	3	2	1	2	5	1	2	2	1
NNW.	2	2	....	....	1	2	1	1	4	3	6	7
Calm.	5	10	9	15	18	22	39	51	55	54	59	67

AUGUST.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 md.
N.	12	9	12	13	8	10	11	5	3	2	2	1
NNE.	8	10	9	13	18	9	9	11	1	4	3	3
NE.	9	9	13	21	8	13	13	17	5	3	1	2
ENE.	8	6	8	5	12	4	7	6	1	1	....	2
E.	7	8	6	11	18	20	15	13	8	9	4	3
ESE.	7	7	11	9	7	12	11	12	6	6	5	5
SE.	4	1	6	4	4	8	4	6	11	8	5	6
SSE.	9	7	6	9	6	5	5	6	9	3	3	1
S.	8	11	12	8	6	6	6	13	17	17	8	5
SSW.	21	21	12	18	16	17	15	21	17	23	19	19
SW.	15	11	18	11	6	11	14	12	29	39	52	46
WSW.	26	23	22	17	16	12	14	13	28	16	44	65
W.	5	3	1	8	4	2	....	5	10	44	30	30
WNW.	1	7	1	6	3	1	....	1	6	12	12	10
NW.	5	2	3	....	3	... ...	1	3	5	8	8	5
NNW.	1	3	3	4	4	3	3	5	5	5	2	1
Calm.	63	62	60	49	70	76	81	57	42	9	11	5

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

AUGUST—Continued.

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 mn.
N.	2	3	4	4	2	3	5	3	11	12	11	18
NNE.	3	3	3	3	3	2	2	2	5	5	2	4
NE.	....	3	4	5	8	5	6	10	7	9	12	10
ENE.	1	....	....	1	4	1	1	4	4	2	6	6
E.	1	....	1	4	3	8	11	8	7	10	7	9
ESE.	3	3	2	2	3	5	5	5	8	4	9	7
SE.	4	3	7	6	3	4	9	9	11	15	8	9
SSE.	4	....	2	3	6	5	10	6	5	8	4	2
S.	5	4	5	10	10	6	10	10	17	12	10	6
SSW.	15	20	18	21	24	21	30	28	24	25	26	29
SW.	52	52	58	76	63	65	45	36	24	22	22	16
WSW.	65	74	67	46	52	42	35	35	24	17	17	20
W.	30	21	14	5	5	5	5	4	10	10	7	7
WNW.	10	11	11	7	2	5	4	3	2	2	2	4
NW.	5	5	6	5	3	4	1	3	1	4	5	4
NNW.	3	3	2	2	3	2	3	3	4	3	3	2
Calm.	6	4	5	9	15	26	27	40	45	49	58	56

SEPTEMBER.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	5	7	10	12	17	12	10	10	4	3	3	3
NNE.	10	15	14	9	8	7	6	7	6	2	3	2
NE.	7	10	11	13	8	15	7	9	5	5	1	1
ENE.	4	7	4	4	9	7	8	4	2	....	....	....
E.	9	12	16	14	13	13	17	15	5	4	1	....
ESE.	8	8	9	9	10	11	6	11	5	4	5	....
SE.	7	5	11	7	6	9	7	9	6	7	3	4
SSE.	10	13	5	9	5	5	6	10	12	3	4	6
S.	9	3	10	8	10	11	12	19	26	22	16	10
SSW.	18	25	15	15	11	7	6	12	24	29	21	16
SW.	26	21	23	21	19	21	20	22	29	35	43	42
WSW.	13	12	12	11	4	4	3	9	25	39	58	70
W.	9	11	7	5	8	4	3	3	9	17	30	31
WNW.	3	4	6	4	1	1	3	4	5	12	7	12
NW.	5	5	1	3	6	1	3	4	6	9	7	3
NNW.	2	2	3	3	3	4	3	2	6	4	1	4
Calm.	64	49	54	62	71	77	89	59	34	14	6	5

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	2	....	3	2	2	5	2	7	3	6	9	6
NNE.	3	6	3	1	3	1	8	7	8	7	7	8
NE.	1	1	3	1	1	2	4	4	7	7	13	13
ENE.	....	2	1	3	2	2	2	1	4	8	7	4
E.	1	2	4	5	5	6	5	5	10	12	10	11
ESE.	....	3	4	1	2	3	8	7	8	13	7	7
SE.	5	....	3	3	7	9	13	13	16	9	15	13
SSE.	8	7	7	6	7	8	5	8	8	11	10	5
S.	1	6	4	9	13	13	17	16	10	9	11	8
SSW.	16	24	24	17	14	17	21	20	17	15	12	19
SW.	63	55	65	76	76	70	62	54	44	33	26	25
WSW.	53	48	54	49	41	27	18	13	14	10	18	18
W.	30	34	24	12	6	10	10	9	5	12	8	8
WNW.	9	10	4	3	3	4	2	2	5	2	2	....
NW.	6	4	1	4	3	5	1	6	8	5	4	4
NNW.	2	1	....	3	3	1	....	4	7	3	4	2
Calm.	9	6	5	14	21	26	31	33	35	47	46	58

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

OCTOBER.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	16	19	22	20	16	19	21	24	19	10	5	5
NNE.	25	26	30	18	20	21	21	34	21	5	8	10
NE.	17	28	22	32	33	17	21	20	6	11	7	6
ENE.	8	7	8	11	8	18	11	8	10	1	2	2
E.	14	12	9	7	11	6	12	9	10	7	4	5
ESE.	3	5	10	6	12	9	8	6	11	5	4	6
SE.	8	8	6	8	9	10	1	5	8	10	8	6
SSE.	3	4	6	9	2	6	2	5	4	6	6	2
S.	4	1	3	1	4	4	3	7	7	8	11	6
SSW.	12	12	10	7	5	5	10	9	19	18	13	19
SW.	8	10	6	5	5	3	1	......	10	23	24	28
WSW.	7	4	5	3	2	3	2	5	12	30	46	51
W.	4	4	2	1	1	4	3	3	16	28	36	33
WNW.	3	4	3	2	2	1	1	1	9	15	16	12
NW.	....	....	....	....	2	2	2	4	7	8	5	7
NNW.	10	4	5	8	3	3	6	7	8	14	4	3
Calm.	75	69	70	79	79	83	89	70	40	18	18	16

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p. m.
N.	10	3	3	2	6	1	4	5	6	13	15	20
NNE.	6	7	9	16	16	11	6	7	9	13	15	20
NE.	8	8	11	2	10	15	13	10	13	9	11	18
ENE.	2	6	4	7	6	7	12	5	11	6	8	7
E.	6	5	6	6	11	17	14	19	22	17	14	12
ESE.	6	8	7	13	9	8	11	15	9	16	11	5
SE.	4	7	8	11	13	11	11	11	8	11	13	12
SSE.	2	6	9	16	10	8	8	9	11	7	6	7
S.	6	13	9	7	8	7	10	4	7	4	7	4
SSW.	20	16	16	16	15	13	12	11	13	12	8	9
SW.	29	32	38	32	25	24	22	18	13	9	8	5
WSW.	56	55	44	32	26	25	15	11	10	4	5	7
W.	30	20	20	19	8	4	5	4	1	4	4	2
WNW.	11	9	5	8	6	5	2	6	5	6	4	8
NW.	3	6	2	3	2	3	4	1	2	3	3	3
NNW.	....	....	2	2	3	1	2	1	6	5	7	5
Calm.	18	16	24	25	43	54	66	77	71	78	78	78

NOVEMBER.

Direction.	1 a.m.	2 a.m.	3 a.m.	4 a. m.	5 a.m.	6 a.m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	28	30	29	37	35	37	25	28	32	10	13	14
NNE.	25	32	31	32	32	25	29	33	20	21	10	7
NE.	24	24	21	25	27	26	29	33	19	16	13	11
ENE.	3	13	13	14	12	9	14	6	9	4	8	5
E.	7	7	7	7	11	10	5	7	8	5	2	8
ESE.	5	4	3	4	4	6	1	3	4	8	6	4
SE.	9	5	3	3	3	3	2	3	7	4	5	2
SSE.	3	1	1	1	2	3	1	3	5	1	1	2
S.	3	1	2	1	1	3	3	1	7	6	6	5
SSW.	4	4	2	3	3	1	1	3	6	12	11	14
SW.	1	1	3	1	....	2	....	1	4	20	32	20
WSW.	3	2	1	2	2	2	3	3	8	26	31	43
W.	....	2	3	1	....	1	1	2	4	16	30	34
WNW.	3	1	....	1	2	1	....	....	7	13	12	11
NW.	2	2	2	4	3	1	3	2	13	5	7	6
NNW.	9	8	6	3	5	4	5	8	9	14	8	9
Calm.	81	73	77	71	68	76	88	74	48	29	15	15

TABLE LXXXI.—*Mean hourly frequency and direction of the wind in Manila, averaged by months, for the period 1892–1898*—Continued.

NOVEMBER—Continued.

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	9	10	13	20	18	20	19	16	10	15	28	23
NNE.	21	13	13	14	20	22	14	13	13	15	19	21
NE.	9	22	19	23	16	21	23	18	14	17	17	21
ENE.	10	8	9	7	16	10	8	7	12	14	10	7
E.	3	6	21	18	28	18	25	20	13	14	10	8
ESE.	5	7	7	13	6	13	8	4	14	13	9	8
SE.	8	6	3	8	1	7	10	8	10	9	10	4
SSE.	4	2	4	3	7	6	5	6	5	6	6	6
S.	6	7	7	9	6	5	2	1	2	3	1	1
SSW.	12	10	12	11	4	4	5	8	6	4	5	4
SW.	24	24	18	10	5	4	5	3	3	2	1	1
WSW.	37	31	33	22	12	6	6	3	4	2	2	2
W.	27	25	17	16	9	4	7	4	2	1	2	1
WNW.	9	10	5	6	3	1	1	2	5	2	2	2
NW.	5	3	8	3	6	1	5	4	4	2	2	3
NNW.	6	8	4	5	4	4	3	5	4	11	7	10
Calm.	15	18	17	22	49	64	64	88	89	80	79	88

DECEMBER.

Direction.	1 a. m.	2 a. m.	3 a. m.	4 a. m.	5 a. m.	6 a. m.	7 a. m.	8 a. m.	9 a. m.	10 a. m.	11 a. m.	12 m.
N.	40	47	41	41	37	43	39	53	40	28	17	14
NNE.	26	29	35	38	35	31	36	30	32	32	15	15
NE.	19	25	27	33	35	30	23	28	26	12	17	18
ENE.	5	8	5	7	11	10	12	9	9	7	8	5
E.	9	7	9	10	4	8	5	5	5	6	2	11
ESE.	4	3	1	5	1	2	4	1	2	2	4	6
SE.	4	2	1	2	2	......	0	1	1	1	2	2
SSE.	2	2	2	2	......	1	......	......	3	2	2	2
S.	1	......	......	......	......	......	......	......	1	3	10	5
SSW.	1	......	1	1	......	......	......	2	2	4	9	11
SW.	......	......	......	......	......	......	......	......	1	14	19	21
WSW.	......	......	......	1	......	......	......	......	15	30	38	44
W.	2	3	1	2	2	......	......	......	8	22	29	34
WNW.	2	3	2	1	1	......	1	......	4	9	12	8
NW.	5	3	4	2	4	5	8	3	5	8	11	6
NNW.	4	4	6	5	9	7	8	14	17	11	5	5
Calm.	89	77	78	63	72	76	77	67	42	22	13	6

Direction.	1 p. m.	2 p. m.	3 p. m.	4 p. m.	5 p. m.	6 p. m.	7 p. m.	8 p. m.	9 p. m.	10 p. m.	11 p. m.	12 p.m.
N.	9	11	21	18	17	24	21	21	17	20	26	29
NNE.	22	20	23	28	34	24	21	15	20	20	22	28
NE.	24	31	24	27	31	28	22	20	16	19	19	18
ENE.	8	8	13	16	18	17	14	7	7	13	11	9
E.	12	12	14	21	24	26	28	18	18	17	17	8
ESE.	6	8	6	20	15	16	15	10	6	10	8	7
SE.	3	3	6	8	7	8	10	8	3	6	1	3
SSE.	......	1	5	7	9	5	4	2	2	1	4	2
S.	8	9	6	5	5	2	3	2	3	1	......	......
SSW.	17	11	12	14	3	2	2	2	2	1	1	......
SW.	18	14	17	7	5	1	4	2	......	......	2	......
WSW.	45	33	17	10	3	2	......	1	......	......	......	1
W.	21	24	17	7	2	1	1	......	1	1	2	1
WNW.	8	8	4	2	2	1	......	2	3	5	......	2
NW.	3	3	6	2	3	3	......	3	5	5	2	3
NNW.	1	5	2	2	4	2	1	5	4	4	5	2
Calm.	8	12	20	19	31	51	67	95	106	90	93	100

From a simple glance at these tables most important facts are deduced, to which we will most briefly and clearly allude.

First. The calms or winds of very light force[1] prevail in all months during the hours of the night, their maximum prevalence being at 6 to 7, and most commonly yet at 7 in the morning, except in the months of November and December, which, according to observations, occur mostly at 9 o'clock at night.

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[1] We say "winds of more calm," or of very slight force, because in Table LXXXI, as well as LXXXII, we see that there is, as to the frequency of calms, too high a number, which perhaps is due to the imperfections of the instruments, which were unable to register the corresponding velocity between 0 and 0.5 meters per second.

Second. The minimum prevalency of calms happens at about 12 o'clock m., or, in other words, at the time of greatest heat.

Third. From the month of December to April, both inclusive, the winds of the third quarter very rarely happen during the night, nor even after 8 oclock in the morning.

Fourth. Nevertheless, these winds generally prevail in all the months of the year from 9, 10, or 11 o'clock in the morning until 3 or 4 o'clock in the afternoon, owing to the sea breezes, which in Manila blow in that direction or quarter. In the month of April these breezes often prevail until 1 p. m., giving way then to the winds from east-southeast, which are proper in this month and which are often strong in the few hours of the afternoon.

Fifth. In those months where the winds of the third quadrant prevail, still in the first few hours of the day the first and second quadrants also prevail to a certain extent. In the month of June these give a maximum frequency from 8 o'clock at night until 8 o'clock in the morning.

TABLE LXXXII.—*Frequency of the wind in Manila, with direction noted by hours, for period 1892–1898.*

Direction.	1 a. m.		2 a. m.		3 a. m.		4 a. m.		5 a. m.		6 a. m.	
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.
N.	230	6.6	242	6.9	255	7.3	261	7.4	254	7.2	227	6.5
NNE.	188	5.5	233	6.8	264	7.7	262	7.6	221	6.4	222	6.4
NE.	190	4.9	235	6.0	245	6.3	297	7.6	294	7.5	270	6.9
ENE.	100	4.0	135	5.4	133	5.3	153	6.1	170	6.7	160	6.3
E.	160	3.6	151	3.4	141	3.2	142	3.2	172	3.9	164	3.7
ESE.	142	3.9	116	3.2	105	2.9	97	2.6	94	2.6	102	2.8
SE.	150	4.3	117	3.3	104	3.0	89	2.5	62	1.8	60	1.7
SSE.	69	3.9	66	3.8	45	2.6	58	3.3	33	1.9	38	2.2
S.	53	3.0	39	2.2	53	3.0	40	2.3	34	1.9	39	2.2
SSW.	88	3.2	99	3.6	69	2.5	65	2.4	47	1.7	45	1.6
SW.	94	1.9	78	1.6	81	1.6	64	1.3	51	1.0	48	1.0
WSW.	65	1.3	62	1.2	58	1.2	52	1.0	36	0.7	31	0.6
W.	30	1.0	32	1.0	23	0.7	28	0.9	21	0.7	19	0.6
WNW.	19	1.5	25	1.9	16	1.2	18	1.4	15	1.2	7	0.5
NW.	29	3.0	25	2.6	25	2.6	19	2.0	28	2.9	19	2.0
NNW.	47	4.8	48	4.9	50	5.1	50	5.1	39	4.0	48	4.9
Calm.	886	6.6	837	6.3	873	6.5	845	6.3	969	7.2	1,041	7.8

Direction.	7 a. m.		8 a. m.		9 a. m.		10 a. m.		11 a. m.		12 noon.	
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.
N.	228	6.5	243	6.9	178	5.1	92	2.6	64	1.8	57	1.6
NNE.	232	6.7	223	6.5	169	4.9	93	2.7	66	1.9	55	1.6
NE.	247	6.3	251	6.4	139	3.6	91	2.3	65	1.7	68	1.7
ENE.	166	6.6	118	4.7	85	3.4	44	1.7	54	2.1	43	1.7
E.	158	3.6	144	3.3	114	2.6	101	2.3	61	1.4	92	2.1
ESE.	79	2.2	99	2.7	97	2.6	89	2.4	93	2.5	98	2.7
SE.	47	1.3	79	2.3	101	2.9	85	2.4	80	2.3	90	2.6
SSE.	35	2.0	59	3.4	65	3.7	38	2.2	45	2.6	46	2.6
S.	41	2.3	82	4.6	132	7.4	104	5.9	90	5.1	72	4.1
SSW.	46	1.7	71	2.6	138	5.0	168	6.1	159	5.8	142	5.2
SW.	50	1.0	74	1.5	194	3.9	322	6.5	345	7.0	373	7.6
WSW.	32	0.6	53	1.1	250	5.0	411	8.2	540	10.7	589	11.7
W.	12	0.4	37	1.2	197	6.3	403	12.9	472	15.1	485	15.5
WNW.	10	0.8	21	1.6	83	6.4	156	12.1	179	13.9	161	12.5
NW.	23	2.4	34	3.5	85	8.7	104	10.7	95	9.8	62	6.4
NNW.	40	4.1	65	6.6	87	8.9	75	7.6	40	4.1	31	3.2
Calm.	1,094	8.2	887	6.6	426	3.2	164	1.2	92	0.7	76	0.6

TABLE LXXXII.—*Frequency of the wind in Manila, with direction noted by hours, for period 1892–1898*—Continued.

Direction.	1 p. m.		2 p. m.		3 p. m.		4 p. m.		5 p. m.		6 p. m.	
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.
N.	57	1.6	55	1.6	73	2.1	79	2.3	78	2.2	83	2.4
NNE.	75	2.2	80	2.3	86	2.5	102	3.0	121	3.5	106	3.1
NE.	73	1.9	110	2.8	111	2.8	140	3.6	134	3.4	142	3.6
ENE.	53	2.1	66	2.6	81	3.2	99	3.9	141	5.6	125	5.0
E.	94	2.1	115	2.6	155	3.5	182	4.1	217	5.6	326	7.4
ESE.	118	3.2	126	3.4	148	4.0	208	5.7	202	5.5	252	6.9
SE.	119	3.4	139	4.0	189	5.4	224	6.4	239	6.8	211	6.0
SSE.	66	3.8	85	4.8	115	6.5	147	8.4	121	6.9	93	5.3
S.	69	3.9	91	5.1	87	4.9	97	5.5	98	5.5	89	5.0
SSW.	150	5.4	154	5.6	158	5.7	151	5.5	149	5.4	129	4.7
SW.	379	7.7	375	7.6	403	8.2	377	7.7	348	7.1	321	6.5
WSW.	588	11.7	532	10.6	436	8.7	342	6.8	241	4.8	189	3.8
W.	398	12.7	327	10.4	213	6.8	122	3.9	59	1.9	36	1.1
WNW.	143	11.1	112	8.7	87	6.7	48	3.7	34	2.6	26	2.0
NW.	53	5.4	53	5.4	59	6.1	43	4.4	34	3.5	26	2.7
NNW.	25	2.5	30	3.1	18	1.8	25	2.5	24	2.4	17	1.7
Calm.	80	0.6	90	0.7	121	0.9	154	1.2	270	2.0	369	2.8

Direction.	7 p. m.		8 p. m.		9 p. m.		10 p. m.		11 p. m.		12 midnight.		Total of observations.
	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	Number of cases.	Per cent.	
N.	77	2.2	88	2.5	101	2.9	132	3.8	167	4.8	183	5.2	3,504
NNE.	87	2.5	77	2.2	83	2.4	114	3.3	126	3.7	161	4.7	3,446
NE.	124	3.2	115	2.9	112	2.9	121	3.1	144	3.7	188	4.8	3,906
ENE.	119	4.7	90	3.6	98	3.9	104	4.1	94	3.7	92	3.6	2,523
E.	370	8.4	349	7.9	292	6.6	255	5.8	232	5.3	188	4.3	4,405
ESE.	269	7.3	245	6.7	245	6.7	248	6.8	216	5.9	175	4.8	3,663
SE.	218	6.2	206	5.9	254	7.3	238	6.8	205	5.9	191	5.5	3,497
SSE.	91	5.2	93	5.3	95	5.4	96	5.5	85	4.8	75	4.3	1,759
S.	89	5.0	93	5.2	89	5.0	78	1.4	73	4.1	43	2.4	1,775
SSW.	150	5.4	141	5.1	125	4.5	105	3.8	100	3.6	105	3.8	2,754
SW.	272	5.5	207	4.2	161	3.3	123	2.5	100	2.0	87	1.8	4,927
WSW.	132	2.6	118	2.3	82	1.6	62	1.2	62	1.2	69	1.4	5,032
W.	46	1.5	31	1.0	35	1.1	40	1.3	38	1.2	29	0.9	3,133
WNW.	18	1.4	24	1.9	26	2.0	25	1.9	19	1.5	18	1.4	1,290
NW.	17	1.7	24	2.5	24	2.5	33	3.4	31	3.2	28	2.9	973
NNW.	13	1.3	26	2.6	44	4.5	40	4.1	52	5.3	49	5.0	983
Calm.	448	3.3	613	4.6	674	5.0	726	5.4	796	5.9	859	6.4	13,390

HOURLY, ANNUAL, AND SEMIANNUAL FREQUENCY.

In Table LXXXII we give the final results of Table LXXXI; that is to say, the yearly summary and the corresponding percentage to each twenty-four hours of the day, and the principal direction.

According to the table, and taking the whole year, we have as follows:

First. The frequency of the calms reaches its maximum equivalent or average at 7 in the morning, then diminishes from 8 to 12, and increases from 2 in the afternoon until 1 in the morning; the frequency at 2, 3, and 4 a. m. is a trifle less than that of 1 a. m., increasing again from 5 to 7 a. m.

Second. Between 1 and 8 a. m. the prevalence of the winds from the north and northeast is very apparent.

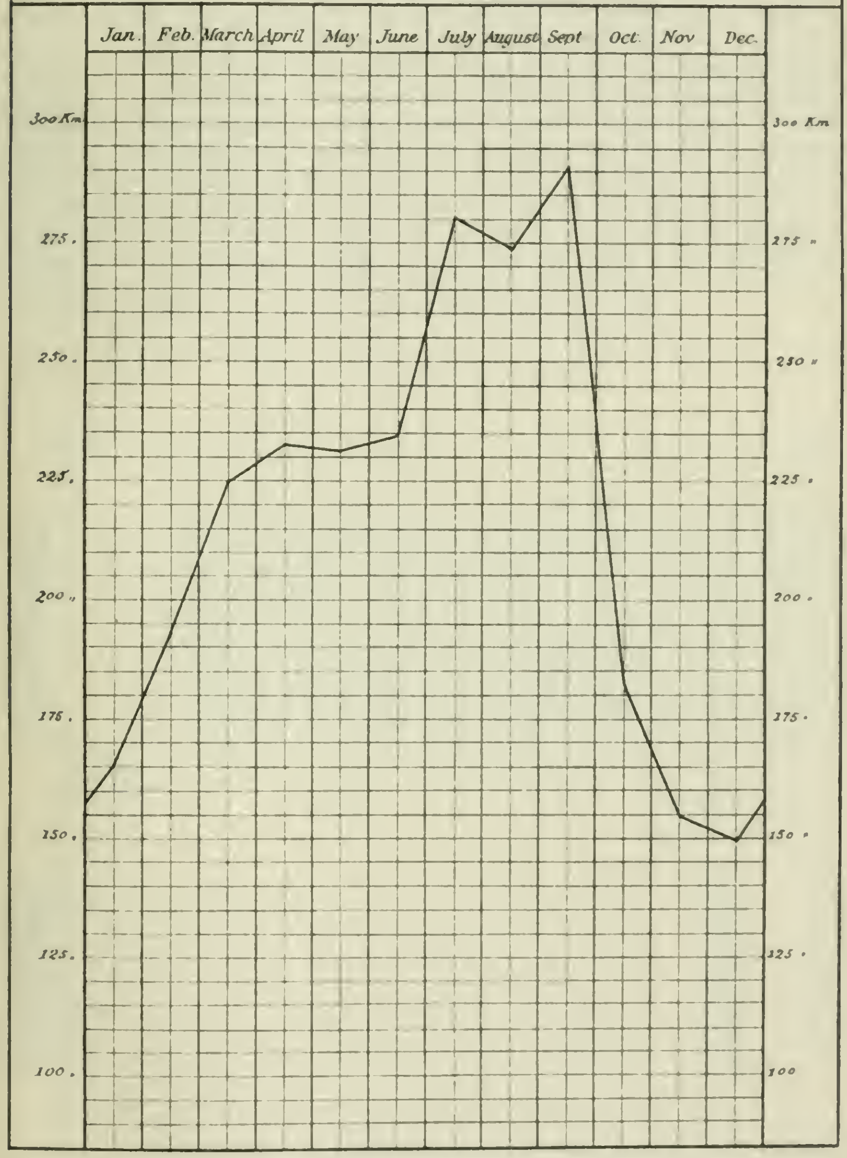
Third. In like manner the prevalence of the winds of the third quadrant is more apparent during the hours of 4 and 5 in the afternoon.

Fourth. From the hours 6 p. m. and 12 midnight winds from east and southeast mostly prevail.

PLATE XXXV.

ANNUAL VARIATION OF THE DAILY VELOCITY OF THE WIND AT MANILA

1885-1898



IV.—ANNUAL VARIATION OF VELOCITY OF THE WIND IN MANILA.

NORMAL AVERAGE OF THE DIFFERENT MONTHS IN THE YEAR.

Table LXXXIII contains the monthly, annual, and semiannual equivalent averages of the daily velocity of the wind in kilometers, taken from hourly observations in this observatory during 1885–1898. In ascertaining the average of the whole period of fourteen years we have obtained for each month the normal averages which are at the footings of the table. Accordingly they show that the force of the winds increases gradually from January to April, decreases a very little in May, increases again in June and July, and decreases for the second time in August, reaching its maximum in September, and decreases again from October to December, in which latter month the minimum annual velocity is attained. The annual average of the daily velocity of wind resulting from the fourteen years of study is 217.8 kilometers. The greater or less degree in which they differ from this annual average and different monthly averages can be seen from the following table:

Table LXXXIII.—*Monthly and annual averages of the daily velocity of the wind in Manila during the period 1885–1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
	km.	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*
1885	232.4	301.5	353.4	367.5	381.8	414.7	449.7	428.3	306.5	218.7	263.5	247.6	330.5
1886	245.5	268.8	345.9	323.0	229.5	223.8	196.4	223.3	288.9	133.9	136.9	126.5	228.5
1887	120.9	150.4	178.5	197.0	178.4	153.6	415.4	141.9	360.3	165.9	122.1	100.3	190.4
1888	116.4	188.7	169.8	189.8	168.7	299.3	364.9	337.1	181.1	121.2	105.3	109.5	196.0
1889	113.7	115.6	184.0	193.9	186.1	173.5	174.7	191.9	110.9	154.1	119.9	158.3	156.4
1890	106.4	116.3	159.9	147.6	110.5	109.0	209.8	199.6	287.1	163.9	119.0	100.5	152.5
1891	112.0	163.1	185.4	184.9	187.6	191.0	291.1	247.8	345.5	77.4	120.5	115.0	185.4
1892	132.8	132.1	169.1	187.6	187.3	172.7	270.7	127.8	312.0	160.0	109.8	95.3	171.4
1893	199.9	219.3	238.9	239.0	321.2	171.2	330.2	299.8	454.1	212.1	220.9	190.6	260.9
1894	213.1	201.9	259.3	257.9	226.6	302.5	281.5	324.2	347.8	214.5	189.1	209.4	252.5
1895	192.7	211.5	250.1	265.1	288.2	255.8	291.2	299.5	391.5	182.1	179.9	171.9	248.5
1896	114.3	121.7	131.5	235.8	337.2	203.9	271.7	353.6	258.8	315.4	133.0	169.8	220.8
1897	216.4	258.8	281.3	277.8	210.1	332.3	203.1	210.9	241.0	196.6	136.9	157.1	226.9
1898	205.8	247.2	240.3	190.2	222.8	276.2	166.5	147.1	188.8	206.6	206.6	138.1	228.0
Average	165.9	192.9	224.8	232.7	231.4	234.5	280.0	273.8	291.0	182.3	154.5	149.3	217.8

Month.	Monthly average.	Difference.
	km	*km.*
January	165.9	−51.9
February	192.9	−24.9
March	221.8	+ 7.0
April	232.7	+14.9
May	231.4	+13.6
June	234.5	+16.7
July	280.0	+62.2
August	273.8	+56.0
September	291.0	+73.2
October	182.3	+35.5
November	154.5	−63.3
December	149.3	−68.5
Average	217.8	

Extreme annual and monthly averages of the period: The greatest annual average, corresponding to 1885, has been 330.5 km.; the least, 52.5 km., that of 1890. The maximum monthly average reached 454.1 km.; the minimum, 794, being that of September, 1893, and October, 1891.

Comparison of the normal averages and the extremes of each month: In the following table we give the maximum and minimum averages of each as compared with the corresponding normal average:

Month.	Normal averages.	Positive.		Negative.	
January	165.9	79.6	(1886)	59.5	(1890)
February	192.9	108.6	(1885)	77.3	(1889)
March	224.8	128.6	(1885)	93.3	(1896)
April	232.7	134.8	(1885)	85.1	(1890)
May	231.4	150.4	(1885)	120.9	(1890)
June	234.5	180.2	(1885)	125.5	(1890)
July	280.0	169.7	(1885)	113.5	(1898)
August	273.8	173.3	(1898)	146.0	(1892)
September	291.0	163.1	(1893)	180.1	(1889)
October	182.3	133.1	(1896)	104.9	(1891)
November	154.5	109.9	(1885)	49.2	(1888)
December	149.3	98.3	(1885)	54.0	(1892)

The greatest number of maximum positive differences have taken place in the year 1885 and the greatest maximum negative differences in the year 1890 being the respective years to which belong the maximum annual average of the period.

V.—MAXIMUM AND MINIMUM DAILY VELOCITY OF THE WIND IN MANILA.

Tables LXXXIV and LXXXV embody, respectively, the maximum and minimum daily velocities of the wind registered in this observatory during the period 1885–1898.

TABLE. LXXXIV.—*Maximum daily velocity of the wind in Manila during the period 1885–1898.*

Year.	January.		February.		March.		April.		May.		June.	
	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.
1885	366.0	22	407.0	20	488.0	26	627.5	1	589.5	17	1031.5	28
1886	478.5	30	398.0	1	478.0	8	436.5	5	415.6	8	641.5	12
1887	263.0	9	238.9	9	271.2	31	612.3	18	383.9	27	361.0	15
1888	229.3	21	405.9	4	254.8	26	250.7	25	293.8	18	525.5	14
1889	174.6	7	431.5	10	268.5	8	310.0	14	255.3	28	333.3	11
1890	233.0	28	215.7	17	250.8	20	277.1	30	217.7	1	207.2	29
1891	169.8	4	255.1	21	247.6	31	314.3	1	262.8	15	384.4	8
1892	285.8	16	199.5	20	288.9	26	252.9	21	319.5	10	422.3	9
1893	272.5	27	313.1	15	398.3	20	337.0	1	1007.5	15	218.3	25
1894	312.2	22	300.4	6	380.5	23	331.7	5	413.0	8	990.0	26
1895	322.0	24	299.8	5	356.8	28	358.0	22	780.6	14	808.7	24
1896	195.4	3	220.7	23	230.7	8	374.7	15	1042.0	17	650.4	6
1897	305.5	8	389.0	21	353.5	12	374.5	8	282.0	15	701.5	27
1898	366.0	29	316.0	15	438.5	16	299.5	8	821.0	31	598.0	18
Average, or mean	283.8	....	242.2	....	336.1	....	368.3	....	506.0	....	562.4	......

Year.	July.		August.		September.		October.		November.		December.		Annual maximum. Km.
	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	
1885	977.5	23	1000.0	24	816.4	4	384.5	13	1159.5	4	412.5	30	1159.5
1886	522.2	12	458.5	13	558.6	21	574.2	9	440.8	18	367.2	18	641.5
1887	994.6	24	440.3	1	1051.1	19	844.9	5	373.6	27	174.6	12	1051.1
1888	1008.1	14	765.3	15	847.6	27	284.0	23	263.0	16	315.5	5	1008.1
1889	450.0	11	606.2	21	251.9	25	575.0	29	336.4	4	542.1	4	606.2
1890	634.8	15	342.2	6	1477.6	30	723.2	17	1037.3	11	170.9	13	1477.6
1891	1022.3	17	580.5	2	847.8	12	197.3	16	732.2	16	487.6	23	1022.3
1892	941.5	22	369.5	15	752.4	7	609.8	9	526.9	22	155.8	4	941.5
1893	1006.5	24	706.9	31	1420.5	30	749.9	1	388.3	22	455.5	5	1420.5
1894	647.0	19	786.0	2	1311.8	17	912.7	3	458.0	17	483.2	22	1311.8
1895	702.8	21	791.5	22	1212.0	1	509.0	1	536.0	2	265.0	17	1212.0
1896	730.4	28	821.2	8	503.5	9	1191.5	4	203.5	3	299.0	23	1191.5
1897	773.5	26	770.0	9	777.5	11	752.5	13	249.5	13	313.0	31	777.5
1898	423.5	31	1038.0	4	429.0	30	629.5	25	843.5	13	331.0	9	1038.0
Average, or mean	773.9	......	676.9	......	875.6	......	638.4	......	539.2	......	340.9	......	1061.4

TABLE LXXXV.—*Minimum daily velocity of the wind in Manila during the period 1885–1898.*

Years.	January.		February.		March.		April.		May.		June.	
	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.
1885	150.5	9	195.0	1	206.0	12	211.0	23	252.0	16	217.0	5
1886	137.5	6	127.0	12	253.0	13	195.6	30	122.6	23	51.4	21
1887	66.0	26	102.5	6	88.0	6	87.7	2	78.9	20	40.5	20
1888	19.1	24	109.2	2	112.9	12	135.5	30	87.8	8	108.1	18
1889	66.5	30	75.9	15	111.4	1	141.5	2	92.6	25	52.2	28
1890	19.3	1	63.7	3	81.7	3	68.0	29	15.4	30	53.5	22
1891	72.7	5	75.4	8	107.8	11	118.9	9	51.3	31	18.3	24
1892	57.7	10	56.0	9	97.8	7	107.1	29	100.3	29	78.5	30
1893	132.5	9	150.6	12	101.6	1	155.5	9	155.5	30	99.6	20
1894	132.6	12	138.2	1	163.7	19	199.8	3	133.5	26	122.0	10
1895	113.3	6	135.0	1	140.0	1	143.2	29	115.3	22	121.3	13
1896	19.2	30	50.6	5	46.8	2	152.9	22	118.0	27	52.5	9
1897	122.5	22	124.0	11	136.5	15	181.5	18	131.0	29	135.0	17
1898	108.0	21	97.5	27	112.5	26	111.5	3	96.0	24	86.5	8
Averages or mean	91.2	....	107.2	....	126.1	....	146.1	....	113.1	.....	90.5	.....

Years.	July.		August.		September.		October.		November.		December.		Annual minimum.
	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.	Days.	Km.
1885	163.0	13	149.5	28	159.0	9	168.5	4	124.0	10	131.5	2	124.0
1886	65.6	7	53.7	28	56.1	28	54.8	21	42.0	20	40.2	31	40.2
1887	49.4	7	33.5	13	58.8	1	60.7	9	45.8	1	47.4	1	33.5
1888	90.9	18	107.1	23	70.9	19	43.9	29	16.4	9	56.6	18	16.4
1889	61.9	25	16.9	9	25.1	17	27.0	6	41.4	7	22.0	6	16.9
1890	30.6	22	39.0	18	15.2	21	16.7	26	18.2	18	61.8	11	15.4
1891	17.8	23	51.8	17	36.2	15	28.4	2	13.5	27	42.1	18	13.5
1892	51.6	4	49.0	21	57.5	19	24.0	17	10.1	6	41.0	9	10.1
1893	120.2	18	100.2	23	120.7	11	97.2	16	106.0	27	72.5	21	72.5
1894	139.5	15	74.8	21	100.5	5	102.0	30	104.0	5	111.4	28	74.8
1895	118.6	28	121.5	5	122.0	9	115.7	23	105.0	23	101.3	22	101.3
1896	102.5	11	132.1	4	95.5	27	84.5	26	78.0	9	70.7	8	19.2
1897	105.0	8	70.5	23	53.0	18	94.5	11	62.0	4	80.5	20	53.0
1898	79.0	6–19	149.5	18	86.5	27	62.5	19–23	3.0	30	35.5	3	3.0
Averages or mean	87.8	......	82.1	......	77.7	......	72.2	......	55.2	......	65.5	......	42.4

AVERAGE NORMAL VALUES OF THE MAXIMUM AND MINIMUM ANNUAL AND MONTHLY VELOCITY.

According to the results at the footings of the tables mentioned the average of the annual maximum velocity is 1061.4 km., and the minimum annual velocity 424 km., there being a difference between them of 1019.0 km.

A gradual increase is to be observed from one month to another in the average values of the maximum and the minimum velocities.

The first increase is from February to July; decreasing somewhat in August, and increasing to the annual maximum average in September. In the following month it decreases gradually until it reaches the annual minimum average velocity in February.

Far different is the relation between the monthly average difference and that of the daily minimum averages. In effect the maximum average values correspond to the month of April, decreasing later without stopping until they reach the minimum average velocity in the month of November. From December they again increase without interruption until the month of April. The greatest minimum averages are those of February, March, April, and May. This we believe is due to the fact that in normal days these are the four months in which the winds often increase in force, and even though in the season of atmospheric disturbances there are normal days to be found in which the minimum velocity of the wind is recorded, generally more in the remaining months of the year than those above mentioned.

MAXIMUM AND MINIMUM DAILY VELOCITY OF THE WIND DURING THE PERIOD 1895–1898.

The maximum daily velocity during the period 1885–1898, 1477.6 km., was recorded the 30th day of September, 1890, when a violent typhoon crossed the center of Luzon, north of Manila.

The minimum velocity was recorded on the 30th of November, 1898, during which the wind blew less than 3 kilometers.

THE MAXIMUM AND MINIMUM DAILY VELOCITY IN EACH MONTH.

In the following table we give the maximum and minimum daily velocity during the whole period corresponding to each of the twelve months in the year:

Month.	Maximum.	Minimum.
	Kilometers.	*Kilometers.*
January	478.5 (1886)	19.2 (1896)
February	431.5 (1889)	50.6 (1896)
March	433.0 (1886)	46.8 (1896)
April	647.5 (1885)	68.0 (1890)
May	1,042.0 (1896)	15.4 (1890)
June	1,031.5 (1885)	40.5 (1887)
July	1,022.3 (1891)	30.6 (1890)
August	1,033.0 (1898)	16.9 (1889)
September	1,477.6 (1890)	25.1 (1889)
October	1,191.5 (1896)	24.0 (1892)
November	1,159.5 (1885)	3.0 (1898)
December	542.1 (1889)	22.0 (1889)

MONTHLY DISTRIBUTION OF THE MAXIMUM AND MINIMUM ANNUAL VELOCITIES.

The manner in which the maximum and minimum annual velocities of the winds are distributed in each month is seen in the following table:

Maximum:		Minimum:	
June	1	January	1
July	3	May	1
August	2	August	3
September	6	September	1
October	4	November	5
November	1	December	3

The maximum velocities occur most frequently in the month of September, and the minimum velocities occur most frequently in the month of November; that is to say, in the first-mentioned month the average of the maxima is greatest, and in the last-mentioned month the average of the minima is greatest. In September there has occurred the greatest number of annual maxima, it being the month in which typhoons most abound; and for this same cause the maximum frequency of velocity is found next in the months of July and August.

TABLE LXXXVI.—*Monthly, annual, and semiannual average values of the hourly velocity of the wind in Manila obtained from the period 1892–1898.*

Month.	0–1 a. m.	1–2 a. m.	2–3 a. m.	3–4 a. m.	4–5 a. m.	5–6 a. m.	6–7 a. m.	7–8 a. m.	8–9 a. m.	9–10 a. m.	10–11 a. m.	11–12 noon.
	Km.	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*
January	4.3	4.6	4.7	5.0	4.8	4.8	4.7	4.9	5.6	7.3	10.8	11.9
February	4.1	3.9	3.8	3.9	4.0	3.8	3.5	3.2	4.4	7.5	11.3	12.9
March	4.7	4.1	4.0	4.1	4.0	4.1	3.9	4.1	5.4	8.8	12.7	14.4
April	4.3	3.9	3.7	3.6	3.8	3.8	3.3	3.6	6.3	10.4	13.8	14.4
May	6.5	6.1	5.8	5.9	5.6	5.3	5.2	5.8	7.9	11.0	13.4	14.7
June	6.2	5.8	6.0	6.0	5.7	5.2	5.3	6.3	7.9	10.4	13.4	15.2
July	7.4	7.6	7.5	7.7	7.2	6.2	5.7	5.7	7.0	9.3	12.6	13.5
August	9	8.1	7.8	8.1	7.4	6.8	7.0	7.5	8.3	10.8	13.4	14.9
September	9.1	9.7	9.7	9.0	8.6	8.0	8.0	8.7	9.3	11.7	14.5	15.6
October	6.7	6.5	6.5	6.3	6.6	5.8	5.7	6.3	7.4	9.4	11.5	12.6
November	4.8	4.9	4.9	4.9	5.2	4.7	4.8	5.3	6.0	7.8	9.9	11.7
December	4.1	4	4.5	4.6	4.7	4.6	5.0	5.3	6.1	7.4	9.7	10.1
Average	6	5.8	5.7	5.8	5.6	5.3	5.2	5.6	6.8	9.3	12.3	13.5
Average, November to May	4.7	4.5	4.5	4.4	4.6	4.4	4.3	4.6	6.0	8.6	11.7	12.9
Average, June to October	7.7	7.5	7.5	7.1	7.1	6.4	6.3	6.9	8.0	10.3	13.1	14.4

Month.	12–1 p. m.	1–2 p. m.	2–3 p. m.	3–4 p. m.	4–5 p. m.	5–6 p. m.	6–7 p. m.	7–8 p. m.	8–9 p. m.	9–10 p. m.	10–11 p. m.	11–12 night.	Average.
	Km.	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*	*Km.*
January	13.1	13.8	12.5	12.5	11.8	9.5	7.9	7.2	5.9	5.3	4.8	4.6	7.6
February	13.4	13.8	13.9	14.9	14.8	12.9	10.7	9.3	7.7	6.8	6.0	4.7	8.1
March	15.5	16.4	16.9	17.8	17.5	15.3	12.3	10.0	8.3	7.7	6.6	5.6	9.3
April	15.9	17.1	18.1	18.8	18.8	16.0	13.0	11.6	10.2	8.7	7.3	5.6	9.8
May	15.3	16.1	17.0	17.2	17.1	15.7	13.8	13.1	10.7	9.3	7.9	6.9	10.6
June	16.3	17.1	17.1	17.1	16.4	14.1	12.1	10.3	9.2	8.5	7.3	6.3	10.2
July	15.3	16.6	17.6	17.2	16.7	15.3	12.9	12.3	10.8	9.9	9.5	8.6	10.8
August	16.2	18.3	19.5	20.2	19.2	17.1	15.9	14.0	11.9	10.5	9.9	9.5	12.1
September	17.1	19.2	19.7	20.5	19.8	18.1	16.0	15.4	12.9	11.6	10.6	9.6	13.0
October	13.9	13.3	13.4	13.5	12.5	11.0	10.0	9.6	8.2	7.2	6.8	6.4	9.0
November	11.1	11.6	11.0	10.0	8.9	7.2	6.5	6.0	5.1	5.0	5.1	5.1	7.0
December	11.5	11.8	11.4	10.8	9.9	7.3	6.1	5.3	4.6	4.3	4.2	4.1	6.8
Average	14.6	15.4	15.7	15.9	15.3	13.3	11.4	10.3	8.8	7.9	7.2	6.4	9.5
Average, November to May	13.7	14.1	14.4	14.6	14.1	12.0	10.0	8.9	7.5	6.7	6.0	5.2	8.5
Average, June to October	15.8	16.9	17.5	17.7	16.9	15.1	13.4	12.3	10.6	9.5	8.8	8.1	11.0

VI.—HOURLY VARIATION OF THE VELOCITY OF THE WIND IN MANILA.

Table LXXXVI contains the averages of the monthly, annual, and semiannual velocity corresponding to each of the twenty-four hours of the day, obtained from hourly observations during the period 1892–1898.

HOURS IN WHICH THE FORCE OF THE WIND IS GREATER OR LESS IN THE DIFFERENT MONTHS OF THE YEAR.

From the monthly average values, as well as the annual and semiannual ones, we obtain the result that the minimum force of the wind is felt generally from 6 to 7 in the morning, and the greater force from 3 to 4 in the afternoon—that is to say, almost in the hours of most heat. Nevertheless, in October, November, December, and January the maximum average is from 1 to 2 in the afternoon. The averages of the period from November to May occur in later hours than those of the period from June to October. The force of the wind from 1 to 8 a. m. seems to be greater in the months of November, December, and January than in the three following months, February, March, and April. On the contrary, in these three latter months, in which the winds from east to southeast prevail, the average velocity in the hours from 11 a. m. to 11 p. m. is greater than in the three former months, the winds from north to northeast prevailing. And yet in the month of April the mean or average velocity from 3 to 7 p. m. is more than that of the months of May, June, and July.

AVERAGE OF THE HOURLY OBSERVATIONS OF THE PERIOD—MONTHLY AVERAGE.

According to the last result obtained in the tables we find that the hourly average of the observations during the period 1892–1898 was 95 km. per hour, or 2.6 km. per second. The monthly averages varied between 130 km. (September) and 68 km. (December), a difference of 62 km.

WINDS WHICH OFTEN ACQUIRE A GREATER FORCE IN MANILA.

Comparing Tables LXXII and LXXXVI it is readily seen that the winds which are accustomed to blow in Manila with greatest force are those of the southwest, which predominate in the months of May to October, and those of the east-southeast, which belong to the months of February, March, and April, and in part to the month of May.

TABLE LXXXVII.—*Maximum velocity of the wind recorded in Manila in the interval of one hour during the period 1885–1898.*

Year.	January.			February.			March.		
	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.
1885	37.0	22	2–3 p. m.	36.5	26	3–4 p. m.	42.5	31	1–2 p. m.
1886	35.0	30	1–2 p. m.	37.5	25	1–2 p. m.	41.0	11	2–3 p. m.
1887	22.7	8	3–4 p. m.	24.5	19	2–3 p. m.	27.1	16	4–5 p. m.
1888	27.2	21	5–6 p. m.	30.5	4	8–9 a. m.	23.2	22 25	5–6 p. m. 4–5 p. m.
1889	25.0	15	0–1 p. m.	39.7	10	8–9 p. m.	27.8	27	2–3 p. m.
1890	23.8	3	11–12 noon.	23.5	17	1–2 p. m. 2–3 p. m.	32.0	20	0–1 p. m.
1891	28.0	25	3–4 p. m.	27.8	10	1–2 p. m.	33.5	31	5–6 p. m.
1892	23.3	26	4–5 p. m.	22.5	20	3–4 p. m.	30.8	26	4–5 p. m.
1893	29.0	27	0–1 a. m.	29.0	24	5–6 p. m.	39.0	19	4–5 p. m.
1894	27.0	22	3–4 p. m.	30.0	14	3–4 p. m.	42.0	27	3–4 p. m.
1895	28.5	29	1–2 p. m.	33.0	4	7–8 p. m.	33.5	15	2–3 p. m.
1896	23.4	24	4–6 p. m.	30.0	23	4–5 p. m.	43.4	8	9–10 p. m.
1897	36.5	1	2–3 p. m.	37.0	16	3–4 p. m.	35.0	27	2–3 p. m.
1898	30.0	7	2–3 p. m.	29.0	19	5–6 p. m.	35.0	15 16	0–1 p. m. 9–10 a. m.
Mean or average velocity	28.3	......	....	30.8	......	....	34.7	......	....

Year.	April.			May.			June.		
	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.
1885	48.0	1	2–3 p. m. 5–6 p. m.	53.0	15	3–4 p. m.	66.0	29	0–1 p. m.
1886	40.0	10 12	0–1 p. m. 2–3 p. m. 3–4 p. m.	37.1	17	4–5 p. m.	56.4	11	4–5 p. m.
1887	51.7	18	3–4 p. m.	41.0	12	8–9 p. m.	49.2	15	3–4 p. m.
1888	27.5	12	0–1 p. m.	36.0	18	2–3 p. m.	48.0	19	3–4 p. m.
1889	27.9	7	4–5 p. m.	32.9	31	6–7 p. m.	39.0	13	3–4 p. m.
1890	29.9	21	2–3 p. m.	25.0	3	4–5 p. m.	30.9	11	2–3 p. m.
1891	31.2	4	5–6 p. m.	36.9	14	6–7 p. m.	45.1	3	2–3 p. m.
1892	30.3	19	2–3 p. m.	36.0	10	5–6 p. m.	35.5	9	4–5 p. m.
1893	32.5	1	3–4 p. m.	63.5	15	4–5 a. m.	23.0	7	3–4 p. m.
1894	31.5	28	3–4 p. m.	44.5	8	3–4 p. m.	68.0	28	7–8 a. m.
1895	38.0	26	4–5 p. m.	50.0	13	11–12 noon	52.2	24	1–2 p. m.
1896	41.3	15	2–3 p. m.	60.5	17	7–8 p. m. 10–11 p. m.	48.5	6	4–5 p. m.
1897	40.0	12	1–2 p. m.	28.5	7	3–4 p. m.	48.0	21	0–1 p. m
1898	29.0	8	1–2 p. m. 2–3 p. m.	50.5	31	5–6 p. m.	41.0	18	1–2 p. m.
Mean	35.6	......	....	42.5	......	....	42.0	......	....

TABLE LXXXVII.—*Maximum velocity of the wind recorded in Manila in the interval of one hour during the period 1885–1898*—Continued.

Year.	July.			August.			September.		
	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.
1885	69.0	22	8–9 a. m.	59.0	11	9–10 a. m.	57.0	4	1–2 p. m.
1886	40.3	12	4–5 p. m.	55.6	14	1–2 p. m.	44.8	8	1–2 p. m.
1887	52.9	18	0–1 p. m.	35.0	4	3–4 p. m.	79.0	19	2–3 p. m.
1888	60.5	21	6–7 a. m.	55.0	15	2–3 p. m.	69.5	27	2–3 a. m.
1889	52.2	16	4–5 p. m.	52.9	23	3–4 p. m.	35.7	24	11–12 noon. 1–2 p. m.
1890	54.8	16	0–1 a. m.	40.8	6	3–4 p. m.	100.0	30	7–8 a. m.
1891	65.7	17	2–3 a. m.	43.1	2	0–1 p. m.	46.0	6	1–2 p. m.
1892	49.1	22	10–11 a. m.	33.3	16	2–3 p. m.	45.1	7	0–1 a. m.
1893	64.0	17	1–2 a. m.	48.8	31	7–8 p. m.	90.0	30	11–12 midnight
1894	47.0	21	3–4 p. m.	48.5	11	7–8 p. m.	89.0	17	9–10 a. m.
1895	53.5	27	3–4 a. m.	50.5	22	7–8 p. m.	65.0	4	6–7 a. m.
1896	47.0	28	8–9 a. m.	63.0	8	4–5 a. m.	44.5	12	4–5 p. m.
1897	47.0	26	10–11 a. m. 11–12 noon.	53.0	9	9–10 a. m.	57.0	14	0–1 p. m.
1898	40.0	31	2–3 p. m.	52.0	5	1–2 a. m.	31.5	15	3–4 p. m.
Mean	53.0	......	....	49.3	......	....	61.0	......	....

Year.	October.			November.			December.			Maximum annual velocity.
	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.	Kilometers.	Days.	Hours.	
1885	35.0	23	2–3 p. m.	96.0	7	3–4 p. m.	39.0	30	0–1 p. m.	96.0
1886	38.2	9	1–2 p. m.	32.3	17	11–12 noon.	25.0	18	1–2 p. m.	56.4
1887	55.0	4	0–1 p. m.	32.8	27	1–2 p. m.	18.9	10	1–2 p. m.	79.0
1888	27.9	1	5–6 p. m.	27.0	19	4–5 p. m.	19.8	2	2–3 p. m.	69.5
1889	45.3	29	8–9 a. m.	30.5	4	6–7 a. m.	42.0	4	2–3 p. m.	52.9
1890	57.8	17	2–3 p. m.	84.1	11	0–1 p. m.	29.0	17	1–2 p. m.	100.0
1891	20.2	23	5–6 p. m.	58.4	16	8–9 a. m.	28.8	23	10–11 a. m.	65.7
1892	47.4	28	1–2 p. m.	36.2	21	5–6 p. m.	25.9	6	10–11 a. m.	49.1
1893	73.0	1	1–2 a. m.	32.1	15	11–12 noon.	36.0	28	10–11 a. m.	90.0
1894	90.0	3	3–4 a. m.	41.0	17	0–1 p. m.	57.0	22	3–4 p. m.	90.0
1895	37.5	1	4–5 p. m.	50.5	2	1–2 p. m.	25.5	27	1–2 p. m.	65.0
1896	74.0	4	8–9 a. m.	20.0	24	0–1 p. m.	33.5	14	3–4 p. m.	74.0
1897	54.0	13	10–11 a. m.	25.0	13 29	2–3 p. m. 1–2 p. m.	26.0	9	2–3 p. m.	57.0
1898	38.5	25	5–6 a. m.	50.0	13	9–10 a. m.	38.0	9	2–3 p. m.	52.0
Mean	49.6	......	....	44.0	......	....	31.7	......	....	71.2

VII.—MAXIMUM HOURLY VELOCITY OF THE WIND IN MANILA.

Table LXXXVII contains the monthly maximum velocities of the wind in Manila in the interval of a single hour during the period 1895–1898.

HOURLY VELOCITIES MOST EXTRAORDINARY OF THE PERIOD.

The maximum most extraordinary velocity of all the period was that recorded from 7 to 8 of the morning of the 30th of September, 1890, during which the wind blew at the rate of 100 kilometers; that is to say, at the rate 27 meters per second. This last sum is nothing but the hourly average of said velocity of 100 kilometers; but in the records of this observatory we find that during the interval of that hour there were wind squalls or puffs which measured 40 meters per second.

The next greatest maximum velocity was of 96 kilometers (26.7 meters per second), recorded from 3 to 4 p. m. on the 7th of November, 1885. The third greatest hourly velocity obtained was of 90 kilometers (25 meters per second), taken from 11 to 12 m. on the 30th of September, 1893, and from 3 to 4 a. m. on the 3d of October, 1894.

All these maximum velocities were occasioned and recorded during the passing of some cyclone north of Manila.

MAXIMUM HOURLY VELOCITIES OF EACH MONTH.

The maximum hourly velocities of each month can be seen in the following table:

	Kilometers.	
January	370	(1885)
February	397	(1889)
March	434	(1896)
April	527	(1889)
May	635	(1893)
June	580	(1890)
July	690	(1880)
August	630	(1896)
September	1,000	(1890)
October	980	(1880)
November	960	(1886)
December	570	(1890)

The fourteen annual maxima are distributed among the different months of the year as follows:

June	1	September	6
July	2	October	2
August	2	November	1

VIII.—MONTHLY, ANNUAL, AND SEMIANNUAL AVERAGE OF FREQUENCY OF THE WINDS IN SOME OF THE PLACES OF THE ARCHIPELAGO.

AVERAGE FREQUENCY OF THE WINDS IN APARRI, ALBAY, AND ILOILO.

Being impossible to discuss, as we would like to, or as it might be well to do, the frequency of the winds in distinct islands and localities of the archipelago, we will content ourselves with discussing this subject, taking the three stations of Aparri, Albay, and Iloilo, north and south of Luzon and in the center of the Visayan Islands. To accomplish this end we give in Tables LXXXVIII and LXXXIX the mean frequency of the winds of Aparri and Albay, obtained by six daily observations taken during 1886–1895. By reason of the fact that the records of said stations are lacking in the observations of some days and hours, we are obliged to omit from both tables some three entire months and here and there some isolated days scattered through the different years of that period. This, however, does not in any way change the relation between the monthly, annual, and semiannual averages.

Table XC contains the average or mean frequency of the winds in Iloilo (though not complete) obtained during the period 1894–1897.

TABLE LXXXVIII.—*Monthly, annual, and semiannual average of frequency of the winds at the meteorological station of Aparri (north of Luzon) 1886–1895.*

Month.	N. NNW.	NW. WNW.	W. WSW.	SW. SSW.	S. SSE.	SE. ESE.	E. ENE.	NE. NNE.	Calm.	Total of observations.
January	11.3	3.5	0.8	1.9	9.1	14.4	46.6	75.7	20.3	1,836
February	12.3	4.8	2.2	4.5	9.4	11.9	38.7	65.9	19.5	1,692
March	15.2	4.3	1.4	6.5	13.6	13.8	33.0	74.6	21.2	1,836
April	18.0	7.3	2.9	4.2	19.7	13.7	25.0	64.6	24.6	1,800
May	25.2	10.4	4.2	8.9	20.0	15.3	20.2	51.9	25.8	1,638
June	19.7	8.1	5.8	22.4	31.8	18.1	11.7	36.4	23.0	1,620
July	28.7	10.9	7.4	25.0	29.8	11.8	7.2	35.6	26.2	1,644
August	24.5	12.9	7.4	33.9	25.7	11.1	5.2	35.4	26.9	1,830
September	25.1	17.0	8.7	25.2	12.9	10.8	9.2	39.9	31.2	1,620
October	16.2	9.1	3.5	9.1	8.4	8.9	25.8	71.1	29.1	1,812
November	6.0	3.1	1.5	3.4	3.4	10.0	14.5	87.5	20.6	1,8[illegible]
December	5.9	2.5	0.5	4.0	5.9	9.2	45.7	89.2	20.1	1,8[illegible]0
Average	17.3	7.8	3.9	12.4	16.1	12.4	26.1	60.7	24.0	....
Average, November to May	13.4	5.1	1.9	4.8	11.6	12.6	36.2	72.8	21.7	....
Average, June to October	22.8	11.6	6.6	23.1	22.3	12.1	11.8	43.7	27.3	....

TABLE LXXXIX.—*Monthly, annual, and semiannual average of frequency of the winds at the meteorological station of Albay (south of Luzon), 1886–1895.*

Month.	N. NNW.	NW. WNW.	W. WSW.	SW. SSW	S. SSE.	SE. ESE.	E. ENE.	NE. NNE.	Calm.	Total of observations.
January	2.1	0.1	0.1	0.0	0.0	0.9	68.9	80.8	32.6	1.668
February	2.9	0.0	6.9	7.4	0.1	1.5	67.1	59.2	22.9	1.680
March	1.0	1.1	11.6	4.4	6.5	3.9	80.3	39.8	35.0	1.836
April	0.4	0.1	1.6	0.8	4.8	4.9	86.2	26.3	49.5	1.746
May	1.0	1.0	2.5	5.9	7.3	5.0	78.4	11.0	70.3	1.824
June	1.9	5.3	11.0	14.1	7.1	5.5	49.5	12.2	67.4	1.740
July	1.8	6.1	27.7	35.7	8.9	7.6	17.8	7.4	69.8	1.644
August	6.0	11.2	21.2	38.6	6.3	8.2	18.5	7.0	66.6	1.836
September	4.8	9.1	27.5	47.4	7.2	3.2	7.9	8.2	59.3	1.746
October	5.1	1.7	8.6	16.1	4.9	4.0	36.1	38.8	66.5	1.818
November	5.3	1.3	2.8	6.4	1.4	4.0	47.6	63.2	45.9	1.602
December	4.3	0.2	1.7	10.5	1.8	1.8	48.8	77.8	35.5	1.824
Average	3.1	3.1	10.3	15.6	4.7	4.2	50.6	36.0	51.8	....
Average, November to May	2.4	0.5	3.9	5.1	4.4	3.1	68.2	51.1	41.7	....
Average, June to October	3.9	6.7	19.2	30.4	6.9	5.7	26.0	14.7	65.9	....

TABLE XC.—*Monthly, annual, and semiannual average of frequency of the winds at the agricultural station of Iloilo, 1894–1897.*

Month.	N. NNW.	NW. WNW.	W. WSW.	SW. SSW.	S. SSE.	SE. ESE.	E. ENE.	NE. NNE.	Calm.	Total of observations.
January	47.0	18.3	1.3	0.0	0.3	0.0	13.7	40.3	3.0	372
February	41.3	21.0	1.3	0.3	0.0	0.0	6.5	41.5	3.8	452
March	38.3	16.0	2.0	0.0	0.7	0.3	9.0	53.0	4.7	372
April	30.3	18.8	4.3	2.3	2.5	3.5	14.3	38.8	5.5	480
May	9.3	8.0	13.5	22.0	17.5	19.0	9.3	14.0	11.5	496
June	10.8	6.5	15.0	20.8	14.8	13.8	12.8	15.5	10.3	480
July	5.5	2.8	16.0	28.3	24.5	23.3	12.0	6.0	5.8	496
August	3.5	1.5	13.5	45.8	33.5	11.3	5.8	4.3	5.0	496
September	6.3	1.3	5.3	43.5	36.5	14.8	6.3	4.0	2.5	480
October	21.3	9.3	5.3	16.3	13.7	8.7	9.7	22.7	17.0	372
November	36.8	7.8	4.8	1.5	2.0	4.3	12.5	41.5	6.0	480
December	42.0	4.0	2.3	1.3	0.8	0.5	9.5	61.3	2.5	496
Average	24.4	9.6	7.1	15.4	12.2	8.3	10.1	28.6	6.5	....
Average, November to May	35.0	13.4	4.2	4.3	3.4	3.9	10.7	41.5	5.3	....
Average, June to October	9.5	4.3	4.0	30.9	24.5	14.4	9.3	10.5	8.1	....

CONCLUSIONS WHICH FOLLOW FROM THESE TABLES.

From these tables we find, first, that at the station in Aparri the winds most prevalent, even in the months of July to September, are those from north to east, and those less prevalent are from the west.

Second. That at the station in Albay the most prevalent winds during the year are those from north to east, with the exception of only three months—July, August, and September—in which the most or greater frequency prevails in those of the third quadrant. During the months of March, April, May, and June there is to be seen a marked inclination in the prevailing winds from the east, corresponding to east to east-northeast, the maximum monthly frequency, so that in other months when winds of the first quadrant prevail those from northeast and north-northeast give a higher degree of prevalency.

Third. In Iloilo the north winds prevail in the months of January, February, March, April, October, November, and December, and winds from the south, principally those comprised of south and southwest winds, prevail in the other months—May, June, July, August, and September.

CHAPTER VII.

CLOUDS.[1]

INTRODUCTION.

This important meteorological element exercises a notable influence upon the climatology, both directly and indirectly, in a greater or less degree, predisposing the general conditions of the atmosphere to diverse alterations, and indicating by its form, disposition, and height, and by its direction, velocity, and position, the great atmospheric changes.

On the other hand, the direction and velocity of the clouds can be an indication, to a greater or less degree, of the diurnal ascending currents, caused for the most part by the greater or smaller terrestrial irradiation, which is an important factor in climatology.

In this chapter we have collected all the information concerning the clouds which has been observed at the observatory in Manila, and we will deal first with that portion of it which refers to the number of clouds; after that we will consider the movements of the clouds, and finally will give the results which have been obtained with the most modern photographic apparatus, by which means we have been able to analyze and compare them, one to another, thus bringing them into relation with the most important climatologic elements, namely, the temperature and atmospheric pressure.

I. NUMBER OF CLOUDS.

WHAT IS UNDERSTOOD BY CLOUDINESS OR NEBULOUSNESS.

The number of clouds constitute what we call a condition of cloudiness or nebulousness, modifying the aspect of the sky in such a manner and in such varying degrees as to be called clear, covered, or variable. The number or quantity of clouds is generally measured by a scale, from 0 to 10, by 0 it being understood that the sky is clear, and by 10 that the sky is completely covered by clouds.

The sky is generally called clear when the scale does not pass over 3 degrees, variable when between 3 and 7 degrees, and clouded when more than the seventh part of the sky is covered.

CLOUDINESS IN MANILA.

In Table XCI we give by months and years the average number of clouds observed to prevail in Manila from the hourly observations made since 1885 up to and including 1898. From a study of these averages an adequate idea may be obtained of the extent of cloudy days in Manila during each year.

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[1] We owe the statements contained in this chapter to Father Algué, director of this observatory, from whose last publication, The Clouds in the Philippine Archipelago, we have used extracts and totals, besides an interesting study upon the solar splendor and the sky of Manila.

TABLE XCI.—*Monthly and yearly average cloudiness at Manila during the period from 1885 to 1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Average.
1885	3.0	3.4	3.0	3.0	2.0	5.0	6.0	6.3	4.0	4.0	4.0	3.0	3.9
1886	3.0	3.0	2.0	2.0	2.8	6.6	6.2	7.0	7.7	6.6	6.8	6.9	5.1
1887	4.0	4.6	4.6	4.9	6.2	6.5	3.0	6.3	8.9	5.2	6.4	5.5	5.9
1888	4.5	2.3	3.1	2.3	4.4	6.8	8.5	7.1	6.0	5.6	4.6	4.5	5.0
1889	4.0	3.4	2.4	2.6	3.1	6.5	6.7	7.4	6.5	6.4	6.5	6.3	5.2
1890	4.9	4.8	3.5	4.7	6.1	6.1	7.7	7.0	8.7	7.6	4.7	4.3	5.8
1891	5.9	3.7	3.5	3.8	5.0	7.5	7.9	8.6	8.1	4.7	6.7	6.7	6.0
1892	5.6	3.6	5.0	3.8	4.9	6.5	7.6	7.1	7.8	6.5	7.1	6.3	5.9
1893	4.7	4.1	4.0	4.0	6.2	6.6	8.0	7.7	7.8	6.5	6.6	6.2	6.0
1894	5.3	5.0	3.5	3.2	6.2	7.8	8.6	7.5	8.8	6.8	7.1	6.1	6.3
1895	5.0	3.7	4.6	3.2	6.8	7.8	6.7	8.1	8.5	5.4	5.4	5.9	5.9
1896	5.1	4.3	4.4	2.7	7.2	6.9	7.8	8.9	7.0	6.4	3.8	4.9	5.8
1897	3.6	4.0	4.3	4.3	5.3	6.5	7.4	8.0	7.3	7.1	6.0	6.9	5.9
1898	5.3	3.9	5.4	5.2	5.9	7.7	8.0	7.5	6.7	7.2	7.1	5.7	6.3
Average	4.6	3.8	3.8	3.5	5.1	6.8	7.5	7.5	7.4	6.1	5.8	5.6	5.6

GENERAL ASPECT OF THE SKY AT MANILA.

Dividing the day into four parts—early morning, morning, afternoon, and evening—we will consider the general aspect of the sky at Manila, using the general denominations of clear, covered, and variable. We take into account only the observations that have been made and verified since the year 1890, which we include in the following tables, XCII, giving the averages.

TABLE XCII.—*General aspect of the sky at Manila, 1890–1898.*

JANUARY.

Year.	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	9	4	18	2	6	23	2	14	15	6	5	20
1891	8	6	17	4	9	18	2	9	20	10	7	14
1892	4	18	9	1	19	11	4	19	8	10	11	10
1893	14	5	12	6	5	20	5	13	13	14	5	12
1894	6	9	16	2	14	15	2	17	12	13	8	10
1895	15	8	8	8	5	18	5	13	13	13	7	11
1896	14	8	9	8	8	15	5	11	15	14	5	12
1897	23	2	6	11	2	18	13	3	15	20	1	10
1898	12	6	13	9	2	20	6	3	22	11	5	15
Average	11.7	7.3	12.0	5.7	7.7	17.6	4.9	11.3	14.8	12.3	6.0	12.7

FEBRUARY.

1890	13	6	9	5	11	12	2	13	13	11	8	9
1891	15	3	10	12	7	9	8	8	12	16	2	10
1892	14	6	9	12	6	11	12	6	11	18	3	8
1893	13	5	10	10	5	13	7	6	15	16	5	7
1894	13	6	9	7	7	14	3	8	17	15	7	6
1895	13	5	10	13	7	8	10	9	9	17	4	7
1896	12	6	11	8	6	15	11	4	14	17	4	8
1897	18	4	6	11	6	11	9	6	13	19	4	5
1898	14	4	10	13	4	11	10	7	11	16	2	10
Average	13.8	5.0	9.3	10.2	6.5	11.5	8.0	7.4	12.8	16.1	4.3	7.8

TABLE XCII.—*General aspect of the sky at Manila, 1890-1898*—Continued.

MARCH.

Year.	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	17	3	11	13	4	14	12	7	12	19	2	10
1891	12	4	15	9	5	17	14	3	11	15	2	14
1892	11	14	6	8	12	11	8	12	11	15	9	7
1893	16	3	12	14	16	1	12	7	12	20	2	9
1894	17	2	12	11	3	17	10	8	13	21	2	8
1895	14	13	4	10	11	10	8	12	11	21	7	3
1896	17	7	7	9	6	16	6	5	20	17	7	7
1897	14	6	11	8	7	16	7	5	19	17	3	11
1898	14	12	5	8	12	11	9	10	12	15	10	6
Average	14.7	7.1	9.2	10.0	8.4	12.6	9.5	7.7	13.8	17.8	4.9	8.3

APRIL.

1890	14	7	9	7	8	15	5	11	14	13	11	6
1891	17	3	10	11	5	14	6	10	14	15	4	11
1892	20	2	8	10	2	18	7	2	21	18	3	9
1893	18	5	7	12	3	15	10	7	13	17	4	9
1894	18	2	10	9	5	16	7	6	17	19	4	7
1895	22	3	5	17	7	6	12	5	13	21	3	6
1896	22	5	3	20	3	7	17	3	10	23	3	4
1897	13	4	13	6	0	24	4	1	25	17	3	10
1898	16	5	9	10	9	11	2	11	17	13	7	10
Average	17.8	4.0	8.2	11.3	4.7	14.0	7.8	6.2	16.0	17.3	4.7	8.0

MAY.

1890	4	6	21	2	11	18	2	13	16	2	11	18
1891	10	11	10	2	13	16	2	16	13	12	7	12
1892	11	5	15	12	4	15	6	12	13	5	12	14
1893	3	11	17	2	10	19	1	15	15	7	13	11
1894	3	11	17	4	12	15	2	21	8	6	16	9
1895	5	8	18	3	12	16	2	17	12	3	15	13
1896	6	17	8	3	16	12	2	16	13	6	16	9
1897	10	4	17	5	2	24	0	3	28	9	4	18
1898	10	6	15	4	7	20	1	18	12	9	8	14
Average	6.9	8.8	15.3	4.1	9.6	17.3	2.0	14.5	14.5	6.6	11.3	13.1

JUNE.

1890	1	4	25	......	17	13	1	8	21	6	5	19
1891	3	21	3	2	20	8	......	20	10	2	21	7
1892	4	9	17	6	11	13	1	13	16	3	12	15
1893	6	4	20	1	3	26	......	7	23	6	5	19
1894	9	11	10	4	10	16	1	20	9	2	16	12
1895	2	11	11	2	12	16	1	20	9	1	14	15
1896	2	7	21	3	7	20	1	16	13	1	13	16
1897	7	7	16	2	9	19	1	12	17	3	7	20
1898	1	17	12	1	17	12	......	21	6	2	19	9
Average	3.9	10.8	15.3	2.3	11.8	15.9	0.7	15.5	13.8	2.9	12.4	11.7

JULY.

1890	1	3	27	1	6	24	0	7	24	1	4	26
1891	4	18	9	......	21	10	1	26	4	3	23	5
1892	2	13	16	1	17	13	......	17	14	3	16	12
1893	3	12	16	1	7	23	1	16	14	2	17	12
1894	1	12	18	0	16	15	0	27	4	0	26	5
1895	8	11	12	8	11	12	2	18	17	4	15	12
1896	3	20	18	2	17	12	1	19	11	4	19	8
1897	2	12	17	1	13	16	......	21	10	2	15	14
1898	1	18	12	......	15	16	......	29	2	1	22	8
Average	2.8	13.2	15,0	1,5	13.7	15.8	0.6	20.0	10.4	2.2	17.4	11.4

TABLE XCII.—*General aspect of the sky at Manila, 1890–1898*—Continued.

AUGUST.

Year	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	0	1	30	1	6	24	0	4	27	1	2	28
1891	1	25	5	......	25	6	......	27	4	......	26	5
1892	7	11	13	2	7	22	......	17	14	2	14	15
1893	2	18	11	......	18	13	......	25	6	1	15	15
1894	1	17	13	3	15	13	2	18	11	0	19	12
1895	4	16	11	4	17	10	0	18	13	1	25	5
1896	......	23	8	1	22	8	......	27	4	......	25	6
1897	1	15	15	......	11	20	......	18	13	2	16	13
1898	3	17	11	2	17	12	1	15	15	3	20	8
Average	2.1	15.9	13.0	1.4	15.3	14.3	0.3	18.8	11.9	1.1	18.0	11.9

SEPTEMBER.

Year	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	......	28	2	......	30	......	......	30	......	......	25	5
1891	2	17	11	1	18	11	......	22	8	1	21	8
1892	7	16	7	1	16	13	......	19	11	4	19	7
1893	1	15	14	......	13	17	......	17	13	1	16	13
1894	3	16	11	2	15	13	2	20	8	3	21	6
1895	1	23	6	3	16	11	1	20	9	0	24	6
1896	2	13	15	2	10	18	1	10	19	5	13	12
1897	1	8	21	......	7	23	......	9	21	......	13	17
1898	3	11	16	2	8	20	0	17	13	4	10	16
Average	2.2	16.3	11.5	1.2	14.8	14.0	0.4	18.2	11,4	2.0	18.0	10.0

OCTOBER.

Year	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	2	19	10	3	23	5	2	25	6	2	17	12
1891	9	9	13	10	13	8	2	22	7	13	6	12
1892	7	13	11	5	14	12	2	16	15	8	12	11
1893	8	11	12	4	14	13	1	16	14	9	11	11
1894	8	8	15	8	10	13	5	17	9	7	17	7
1895	9	14	8	12	11	8	9	12	10	9	13	9
1896	3	10	18	4	11	16	3	13	15	6	7	18
1897	5	16	10	3	8	20	1	11	19	0	14	17
1898	8	14	9	5	16	10	1	21	10	1	16	14
Average	6.5	12.7	11.8	6.0	13.3	11.7	2.3	17.0	11.7	6.1	12.6	12.3

NOVEMBER.

Year	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	12	7	11	8	5	17	6	8	16	16	7	7
1891	7	12	11	7	17	6	2	21	7	7	17	6
1892	5	13	12	3	16	11	1	20	9	6	15	9
1893	4	11	15	2	10	18	1	15	14	5	10	15
1894	6	12	12	4	11	15	6	15	9	8	15	7
1895	7	15	8	8	12	10	4	15	11	10	16	4
1896	12	3	15	9	1	20	6	15	24	22	16	8
1897	9	4	17	2	7	21	1	8	21	9	7	14
1898	6	17	7	3	16	11	1	17	12	7	17	6
Average	7.6	10.4	12.0	5.1	10.5	14.4	3.1	13.2	13.7	10.0	11.5	8.5

DECEMBER.

Year	Early morning.			Forenoon.			Afternoon.			Night.		
	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.	Clear.	Clouded.	Variable.
1890	19	4	8	13	5	13	10	8	13	20	5	6
1891	5	14	12	1	19	11	0	26	5	6	14	11
1892	3	8	20	3	7	21	3	9	19	17	4	10
1893	6	8	17	1	19	11	0	20	11	8	10	13
1894	7	16	8	5	15	11	3	19	9	9	13	9
1895	9	11	11	5	14	12	1	16	14	12	8	11
1896	14	5	12	3	6	22	4	2	25	21	2	8
1897	5	10	16	2	11	18	4	14	17	9	9	13
1898	15	10	6	3	10	18	2	12	17	15	8	8
Average	9.2	9.5	12.3	4.0	11.8	15.2	2.5	14.0	14.5	13.0	8.1	9.9

IMPORTANT OBSERVATIONS.

If we closely examine the preceding tables, we will find that they contain some interesting details of importance in climatology. Comparing some months with others, we will see that the clear early mornings, mornings, afternoons, and evenings, or nights increase in proportion nearly regularly, beginning with August and increasing until April, when they reach their maximum average. On the other hand, the number of clouded early mornings, mornings, afternoons, and nights decrease in almost regular progression from April to August. The number of clouds, or cloudy afternoons, increase, also, progressively, until August, for the reason that tornadoes develop, particularly after midday, from the month of April until the month of August, when they begin to diminish. For this same reason it may be noted that the number of clear afternoons, and even nights, is greater in March, a month generally free of tornadoes, than in April, since March is the clearest month of the whole year, especially during the mornings and early in the morning. Regarding the clear correlation of the early mornings, mornings, afternoons, and nights during the different months it will be observed:

(1) That in the months of December, January, February, March, and April the number of clear early mornings and nights is much greater than the number of cloudy ones, beginning to increase gradually in December; that in March the number of clear nights and early mornings is twice as great as the number of cloudy ones, and this proportion is observed until April, when it begins to decrease in May very rapidly and continues, successively, during the other months, so that in August the number of cloudy mornings and nights is much greater than the number of clear mornings and nights.

(2) From April the number of cloudy and variable afternoons begins to increase very perceptibly and continues to August, probably for the reason that the tornadoes develop during this month, and especially during the afternoons.

(3) Generally from May until October the number of clear early mornings is greater than that of clear nights.

(4) On the other hand, the contingent of clear nights is greater than of clear early mornings in January, February, and March.

(5) From April until November the mornings are generally clearer than the afternoons.

GRAPHIC REPRESENTATION OF THE STATE OF THE SKY AT MANILA.

In Engraving XXXVI we give a graphic representation of the numeric averages of the preceding outlines for the better understanding of the conditions which we have just noted.

SOLAR SPLENDOR (SUNSHINE).

The number of clouds bear a close relation to the duration of the sunshine upon the horizon. Since the year 1897 the sunshine of Manila has been observed at the observatory by means of a Whipple-Casella register (Universal sunshine recorder).

SENSIBILITY OF THE HELIOGRAPH.

Concerning the value of the observations published regularly since the year 1890, in the monthly bulletins of the observatory, it is well to refer to what has been written upon this subject by writers who have interested themselves in such investigations. The result shows that the recorders heretofore used were not sensible when the sun was near the the horizon, for instance, by less than six grades of height.[1] The greater or less degree of sensibility depends at times upon local circumstances, and always is influenced by the vapor of the horizon from the accumulation of the stratus and the same physical constitution of the air and of greater or less abundance of foreign elements with which the air is generally impregnated. The determination of this sensibility is empiric in each locality, as is seen by comparing the register of days entirely clear with the duration of sunshine at the horizon. By this means it will be found how long a time the sun's rays are inefficacious for registry, and this time being ascertained by means of physical induction the most important constant of the apparatus will thus be determined.

DETERMINATION OF THE EFFECTIVE AND INEFFECTIVE SUNSHINE.

This constant of the apparatus we have found by the following proceeding:

Consulting the published observations since the year 1890, and some not published from 1887, we have grouped by months and days the time in which the greatest possible efficacy of sunshine was registered, after having, at the same time, closely examined the aspect of the sky corresponding to said days, especially by the waning and setting sun.

The result is expressed in the following table:

	Jan.	Feb.	March	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
Average number of hours of actual sunshine	11.24	11.40	12.3	12.28	12.47	12.57	12.58	12.46	12.18	11.49	11.29	11.19
Average number of hours of effective sunshine	10.53	11.18	11.30	11.48	11.32	11.17	11.23	11.15	11.0	10.56	10.40	10.30
Differences.	0.31	0.22	0.33	0.40	1.15	1.40	1.35	1.31	1.18	0.53	0.49	0.49

By this it can be seen that in February the sun's rays are more effective than in June, and generally from October to March, both months inclusive, they are more effective than during the rest of the year. What can be the reason of this difference? We are satisfied to indicate that this efficacy of the sunshine is closely related to the yearly oscillation of the tension of the watery vapor, as can be seen when it is compared with the monthly curve of this element. It is,

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[1] The heliographs up to date invented are reduced to three classes: (*a*) Thermometric heliographs, in which the principal agent of the record of sunshine is the thermal power of its rays. (*b*) Heliographs provided with photographic apparatus in which the sun's rays act chemically upon determined substances. (*c*) Heliographs which we might call termical mechanics, and which are those that by way of heat concentrated from the sun's rays produce the mechanical effect of burning substances, as paper, powder, etc.

PLATE XXXVI.

GENERAL APPEARANCE OF THE SKY AT MANILA

Clear ——— *Cloudy* - - - - *Variable* .....

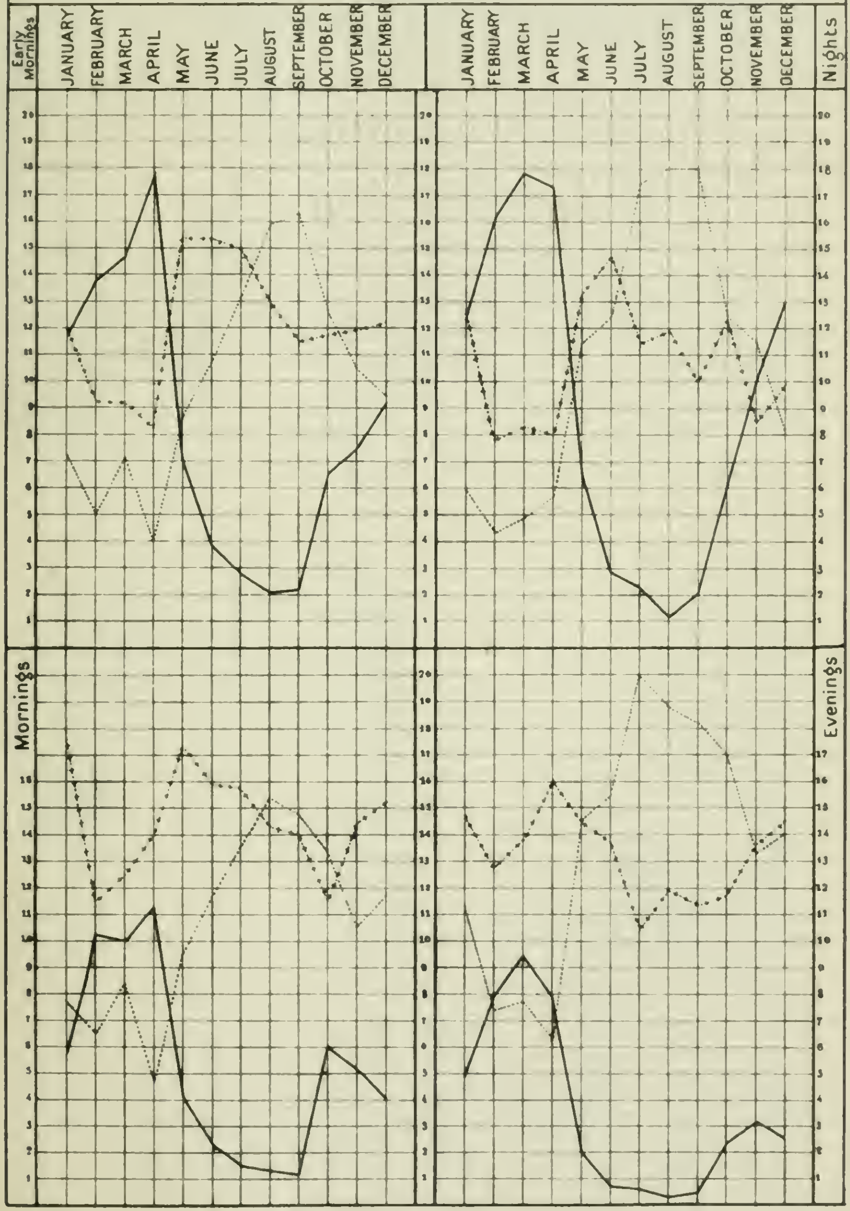
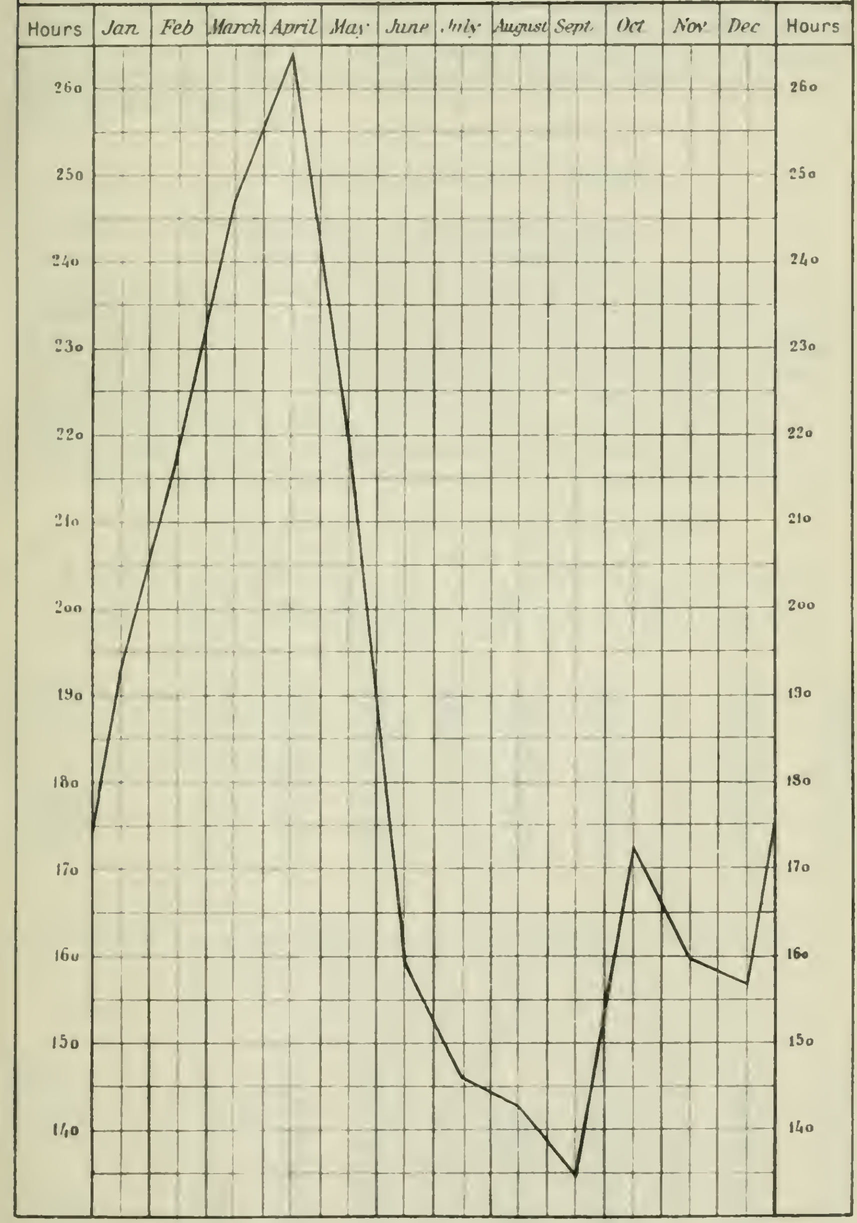


PLATE XXXVII.

ANNUAL VARIATION OF THE EFFICACY OF THE SUN'S RAYS (INSOLATION) AT MANILA

1890-1898



besides, inversely proportionate to the monthly variation of the relative humidity, and finally bears relation directly to the monthly variation of the atmospheric pressure.

With the preceding data we can determine with sufficient approximation the constant of the apparatus, which is called twilight correction, which for the months January, February, March, April, October, November, and December is approximately forty minutes, and one hour twenty-eight minutes for the other five months, May, June, July, August, and September.

II.—DIRECTION OF THE CLOUDS.

PRACTICAL DETERMINATION OF THE MEAN DIRECTION OF CLOUDS, HIGH, LOW, AND INTERMEDIATE.

Another practical result of the observations of clouds has been the determination of their medial direction. There have greatly served us for this purpose the observations made in the observatory in Manila from the year 1890 to 1897. The practical result of these observations, taken from the work entitled Clouds in the Philippine Archipelago, is published in Table XCV, which we do not doubt will be of great practical utility in ascertaining the existence, location, and direction of cyclonic vortices by means of the direction of the clouds.[1]

Table XCV.—*General movement of the atmosphere in Manila.*

HIGH CLOUDS (BETWEEN 19,000 AND 5,000 METERS)—CIRRUS AND CIRRO STRATUS.

Month.	From SE. to NW.	From S. to N.	From SW. to NE.	From W. to E.	From NW. to SE.	From N. to S.	From NE. to SE.	From E. to W.	Total.
January	0.0038	0.0044	0.0041	0.0006	....	0.0004	0.0002	0.0017	0.0152
February	.0020	.0023	.0026	.0008	....	.0003	.0015	.0010	.0105
March	.0028	.0037	.0005	.0006	0.0003	.0001	.0001	.0009	.0090
April	.0007	.0024	.0027	.0058	.0016	.0018	.0014	.0003	.0167
May	.0032	.0006	.0022	.0021	.0023	.0012	.0048	.0057	.0221
June	.0020	.0017	.0018	.0026	.0008	.0024	.0059	.0094	.0266
July	.0020	.0007	.0013	.0015	.0011	.0005	.0087	.0139	.0297
August	.0052	.0012	.0012	.0008	.0001	.0020	.0100	.0173	.0378
September	.0016	.0007	.0010	.0003	.0017	.0019	.0105	.0093	.0270
October	.0047	.0001	.0021	.0002	.0015	.0003	.0034	.0095	.0218
November	.0054	.0027	.0013	.0011	.0007	.0008	.0032	.0064	.0216
December	.0039	.0023	.0023	.0018	.0002	.0004	.0012	.0036	.0157
Year	.0373	.0228	.0231	.0182	.0103	.0121	.0509	.0790	.2537

INTERMEDIATE CLOUDS (BETWEEN 5,000 AND 2,000 METERS)—HIGH CUMULUS, CIRRO-CUMULUS, HIGH STRATUS, CUMULO-NIMBUS.

Month.	From SE. to NE.	From S. to N.	From SE. to NE.	From W. to E.	From W. to SE.	From N. to S.	From NE. to SW.	From E. to W.	Total.
January	0.0011	0.0002	0.0006	0.0001	....	0.0007	0.0074	0.0191	0.0282
February	.0004	....	.0001	....	....	.0003	.0037	.0138	.0183
March	.0011	.0002	.0004	.0003	....	.0001	.0039	.0166	.0226
April	.0013	.0007	.0003	.0003	0.0005	.0007	.0020	.0108	.0166
May	.0028	.0006	.0009	.0004	.0005	.0004	.0013	.0064	.0133
June	.0037	.0015	.0017	.0014	.0008	.0002	.0002	.0085	.0180
July	.0012	.0012	.0017	.0041	.0013	.0004	.0020	.0026	.0178
August	.0015	.0018	.0047	.0058	.0011	.0007	.0015	.0035	.0206
September	.0007	.0005	.0053	.0040	.0007	.0009	.0007	.0010	.0138
October	.0022	.0003	.0022	.0013	.0016	.0003	.0056	.0071	.0207
November	.0034	.0011	.0006	.0008	.0004	.0005	.0040	.0153	.0261
December	.0039	.0006	....	.0001	....	.0002	.0073	.0167	.0288
Year	.0231	.0087	.0215	.0179	.0069	.0054	.0396	.1214	.2448

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[1] See also on this point what is said in Chapter VIII, paragraph 8.

TABLE XCV.—*General movement of the atmosphere in Manila*—Continued.

LOW CLOUDS (BETWEEN 2,000 AND 200 METERS)—CUMULUS, NIMBUS, STRATUS, CUMULO-STRATUS.

Month.	From SE. to NW.	From S. to N.	From SW. to NE.	From W. to E.	From NW. to SE.	From N. to S.	From NE. to SE.	From E. to W.	Total.
January	0.0005	....	0.0002	....	....	0.0002	0.0054	0.0112	0.0175
February	.0004	....	.0001	....	....	.0003	.0037	.0119	.0164
March	.0014	....	.0005	0.0002	....	....	.0027	.0117	.0165
April	.0008	0.0002	.0003	.0003	0.0002	.0001	.0015	.0127	.0161
May	.0032	.0011	.0017	.0016	.0006	.0004	.0014	.0082	.0182
June	.0043	.0007	.0035	.0038	.0002	.0002	.0003	.0071	.0201
July	.0022	.0004	.0064	.0059	.0011	.0010	.0007	.0033	.0210
August	.0019	.0006	.0047	.0058	.0011	.0007	.0015	.0035	.0198
September	.0010	.0013	.0083	.0089	.0018	.0012	.0010	.0020	.0255
October	.0006	.0001	.0017	.0019	.0009	.0007	.0037	.0087	.0183
November	.0018	.0010	.0008	.0008	.0009	.0007	.0045	.0109	.0214
December	.0020	....	....	....	....	.0003	.0044	.0100	.0167
Year	.0201	.0054	.0282	.0292	.0068	.0058	.0308	.1012	.2275

RESULTANT DIRECTION OR MONTHLY AVERAGE.

Employing the form used by Lambert, we have deduced from the outlines of the preceding tables the results which, at length, further on, we express in regard to each month of the year. Adding the resultant direction of the winds, which were given in the preceding chapter, we have so arranged them that they can be readily compared with the changes which verify themselves in the atmosphere, from the surface of the sea to the regions of high temperature.

Month.	High clouds.	Intermedial clouds.	Low clouds.	Winds.
	° ′	° ′	° ′	° ′
January	S. 06–00 E.	N. 79–34 E.	W. 76–59 E.	N. 41–07 E.
February	S. 11–20 E.	N. 78–04 E.	N. 80–08 E.	N. 83–13 E.
March	S. 17–29 E.	N. 83–18 E.	N. 87–04 E.	S. 84–18 E.
April	S. 82–54 W.	N. 86–25 E.	N. 88–40 E.	S. 63–31 E.
May	N. 73–29 E.	S. 78–59 E.	S. 71–32 E.	S. 16–55 E.
June	N. 75–23 E.	S. 61–15 E.	S. 40–09 E.	S. 0–41 W.
July	N. 76–28 E.	S. 54–58 W.	S. 54–15 W.	S. 34–28 W.
August	N. 83–53 E.	S. 53–45 W.	S. 55–38 W.	S. 40–48 W.
September	N. 62–58 E.	S. 66–07 W.	S. 69–26 W.	S. 39–41 W.
October	S. 47–25 E.	N. 77–36 E.	N. 74–25 E.	S. 75–32 E.
November	S. 68–44 E.	S. 89–04 E.	N. 82–49 E.	N. 27–45 E.
December	S. 55–29 E.	N. 85–20 E.	N. 82–10 E.	N. 24–13 E.

These results, which only refer to the currents observed in Manila, can be taken, however, as average representations of the general direction of the atmospheric movements, at least as to the central parts of the archipelago; and mariners may consider them as an expression of the dominating direction of the different aëric currents, not only in the interinsular seas, but those comprehended in the zone of the archipelago.

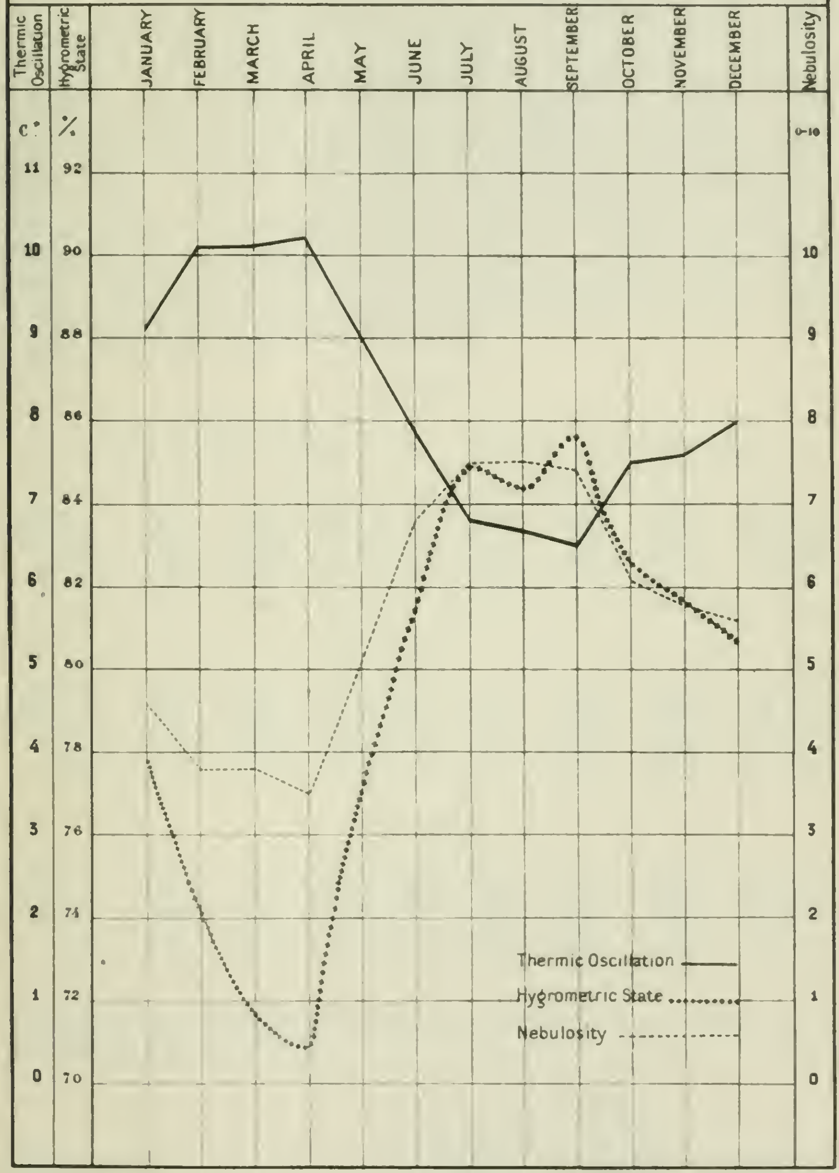
For the convenience of the observers, and especially of those mariners touching at these coasts, we represent in Engraving XXXIX the verified average direction of currents corresponding to the different regions of the atmosphere.

In said engraving, we begin the series of months with October, for the reason that in October and September the most noted changes of direction take place.

Referring to each one of the months, the directions are to be indicated as to their relation to each other with the cross of interrupted

PLATE XXXVIII.

THERMIC OSCILLATION, HYGROMETRIC STATE AND NEBULOSITY AT MANILA



lines, in order to understand its position. We give to the numbers found and their graphic representation only provisional averages, because the observations from the year 1890, having been made by a number of persons and it also being very difficult to obtain exact information of some facts, it is not strange that some observations appear mixed up and that some groups are confounded with others, resulting in an alteration of the averages. The brusque changes in the direction of the high clouds of March and April are indeed notable, especially when we consider the fact that during the month of April the false rumors are not so abandant as in May, June, July, August, and September; nor are there high hurricanes on the China Sea, which would be the only two causes that could falsify the normal direction of the clouds. This is not the place to discuss the cause of these general movements of the atmosphere of Manila. With special reference to the greater convenience of the observer, we have calculated the result of the general movements, grouping the months in conformity to the division of the year made with regard to the hurricanes.[1] The result we publish in the following tables.

HIGH CLOUDS.

	From SE. to NW.	From S. to N.	From SW. to NE.	From W. to E.	From NW. to SE.	From N. to S.	From NE. to SW.	From E. to W.	
Group I	0.0125	0.0107	0.0095	0.0038	0.0005	0.0012	0.0030	0.0072	0.0484
Group II	.0079	.0054	.0080	.0130	.0058	.0059	.0208	.0293	.0961
Group III	.0159	.0046	.0056	.0024	.0040	.0050	.0271	.0425	.1071
Total	.0363	.0207	.0231	.0192	.0103	.0121	.0509	.0790	.2516

INTERMEDIATE CLOUDS.

	From SE. to NW.	From S. to N.	From SW. to NE.	From W. to E.	From NW. to SE.	From N. to S.	From NE. to SW.	From E. to W.	
Group I	0.0065	0.0010	0.0001	0.0004	....	0.0013	0.0223	0.0662	0.0978
Group II	.0090	.0040	.0076	.0065	0.0031	.0017	.0055	.0283	.0657
Group III	.0079	.0037	.0128	.0119	.0038	.0024	.0118	.0279	.0822
Total	.0234	.0087	.0205	.0188	.0069	.0054	.0396	.1224	.2457

LOW CLOUDS.

	From SE. to NW.	From S. to N.	From SW. to NE.	From W. to E.	From NW. to SE.	From N. to S.	From NE. to SW.	From E. to W.	
Group I	0.0043	....	0.0008	0.0002	....	....	0.0162	0.0448	0.0663
Group II	.0105	0.0021	.0119	.0116	0.0021	0.0017	.0059	.0396	.0857
Group III	.0053	.0044	.0211	.0225	.0049	.0033	.0067	.0281	.0963
Total	.0201	.0068	.0338	.0343	.0070	.0050	.0288	.1125	.2483

Applying the formula of Lambert there result for each group the following mean directions:

	High clouds.	Intermediate clouds.	Low clouds.
Group I	S. 4° 51′ E.	N. 73° 28′ E.	N. 83° 51′ E.
Group II	N. 82° 28′ E.	S. 80° 44′ E.	S. 76° 56′ E.
Group III	N. 74° 41′ E.	S. 37° 51′ W.	S. 46° 23′ W.

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[1] Reference should be made to the book "Philippine Hurricanes or Cyclones," on page 17, chapter 8, paragraph 5, of this treatise.

GENERAL CIRCULATION OF THE ATMOSPHERE AT DIFFERENT LATITUDES IN THE NORTHERN HEMISPHERE—GRAPHIC REPRESENTATION OF SAID CIRCULATION.

Finally, in order to complete this investigation, we have traced another graphic outline in comparison with the general currents of the atmosphere at four different latitudes—Davao, Manila, Zikawei, and Blue Hill. It is sufficient to note that the direction of the high clouds during the summer, as regards Manila, differs little from the observed direction in Jamaica[1] during the summer. It also differs very little from the direction of our intermedials observed in both tropical stations. The directions of the low clouds differ more from the fact that they are influenced by the tornadoes.

We have taken the directions observed at Zikawei and Blue Hill from an interesting book written by Father Marcos Dechevrens, of the Jesuit order.[2] The observations regarding Davao are the fruit of the patient work of the Jesuit missionary, Father Baltasser Ferrer, who, in spite of the arduous duties of his apostolic ministry, found time to devote to science, rendering an invaluable service to the same by his notes, since the observations made by him are the only ones up to date which have been made with any regularity in a location so near the equator as is Davao. It will be noted that the direction of the high clouds at Manila is always to the east, while the direction of the highest latitude is always to the west. It is especially interesting to call attention to the direction of the clouds at Davao, which are exactly opposite to the direction of the clouds at Zikawei and Blue Hill. It appears that this change, noted most near the tropical line, has been observed by Poey in Habana (Lat. N. 23°, 9′). It is important to investigate in which zone the principal currents begin to be occidental.

It is to be regretted that the observations made in the observatory at Hongkong (Lat. 22° 18′) are not sufficiently full to clear up this point. Besides this, during the time the sun is in the southern hemisphere, or rather, it may be said, during the months of October, November, December, January, February, and March, the tumults of the second quadrant prevail, and during the other months of the year those of the first quadrant. We content ourselves with these indications, because it is not our general purpose to investigate here the causes of the diverse circulation of the zones in the different latitudes.

Having ascertained the normal direction of the diverse elements of the atmosphere, it remains for the observer to distinguish with greater accuracy whatever concerns the value of the signs of the hurricanes taken from the direction of the clouds.

In this manner the observer can utilize the indications of the directions of the clouds when the normal directions are known, and the provisions of the atmospheric disturbances can be seen best in the publication Philippine Hurricanes and Cyclones, page 156; also in Chapter VIII of the treatise.

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[1] See publication Clouds and Cloud-Drift in Jamaica, by Hall, Jamaica, 1896.

[2] Movements of the Different Couches of the Atmosphere, by Jesuit Father Dechevrens, Rome, 1896. (Extract from the memorials of the Pontific Academy of New Lincei.)

PLATE XXXIX.

GENERAL MOVEMENTS OF THE ATMOSPHERE AT MANILA

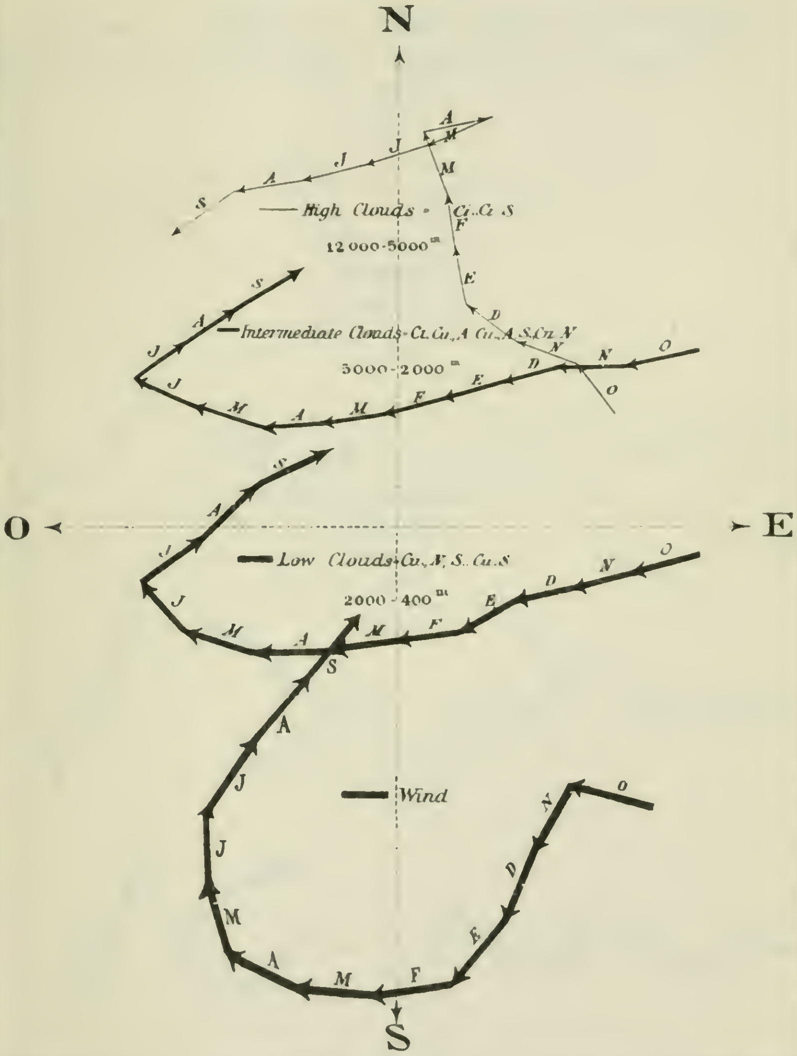
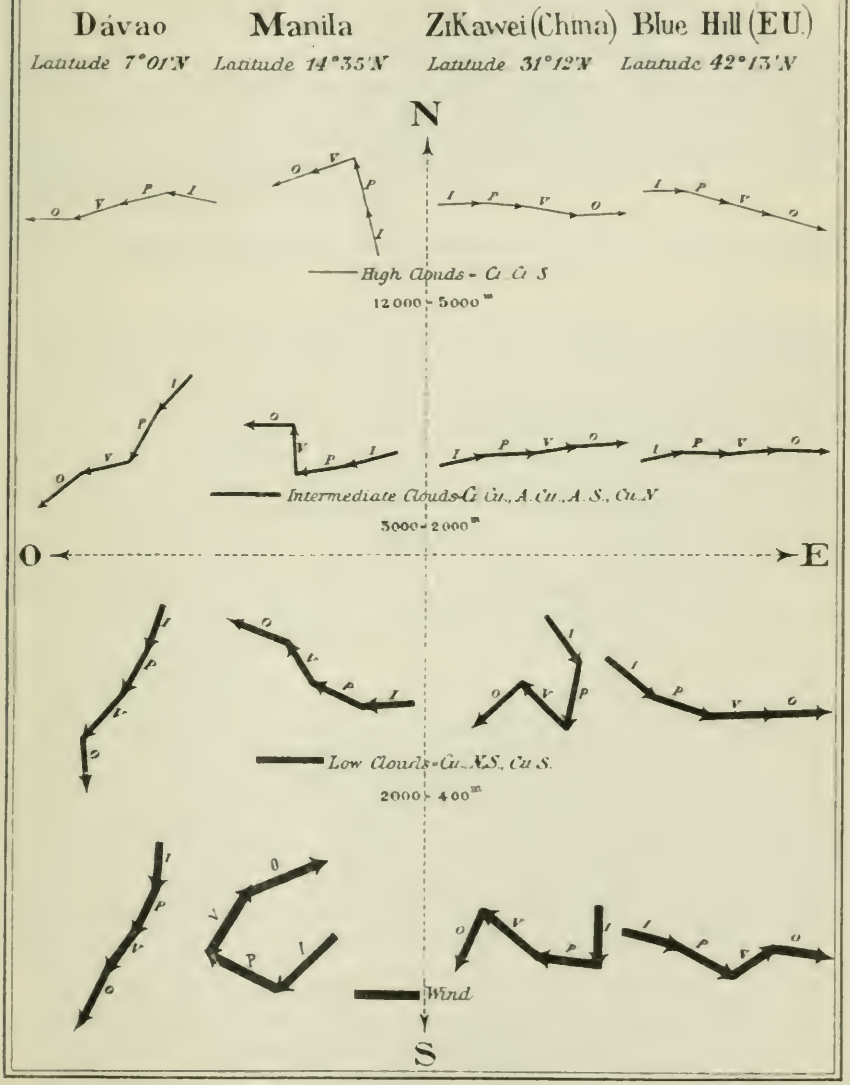


PLATE XL.

GENERAL CIRCULATION OF THE ATMOSPHERE
AT
DIFFERENT LATITUDES



III.—PHOTOGRAMMETRY OF THE CLOUDS.

In the second paragraph of the first chapter this observatory was invited to take part in the international measurement of clouds to be made. We will briefly mention the results obtained by this analysis, which figure in the general tables which we will publish in the continuation of this work.[1]

AVERAGE HEIGHT—TABLES XCVI A AND XCVI B.

In the first place we give the monthly average height of the clouds, dividing these into three groups, as, for instance, high clouds, which are represented by the cirrus and cirro-stratus;[2] the intermedials, represented by cirro-cumulus, high cumulus, high stratus, and high nimbus; and the low clouds, represented by cumulus, nimbus, stratus, cumulo-stratus, and fr.-cumulus.

TOTAL AVERAGE DIRECTION AND VELOCITY OF THE CLOUDS—TABLES XCVI A, XCVI B, AND XCVI D.

If these totals are compared with those given in the preceding paragraph, it will be found that the difference is sufficient to interest one and call attention to the study of the same. It is enough to note that the different photographic methods do not add precision to the observations of the directions of clouds made with the simple nephoscope, or, it may be better said, the direction of the clouds can be observed with greater precision with the simple nephoscope than by employing the theodolite and the phototheodolite. The averages which we give in the preceding paragraph, corresponding to the different years, is of more scientific value than that which is based upon observations made in the transcura of a year, more or less, as in this table.

The direction of the high clouds has resulted differently in the months of January, March, October, and November, agreeing notably in the other months.

The average directions of those of January, February, December, and especially those of July and August, disagree very materially. However, it must be noted that the photographic observations give oriental directions and that the result of the direct observations is that during several years the directions are occidental for the same months. This appears to confirm all that we have written concerning the monsoons of the southwest or, better said, the occidental currents; but in the case of atmospheric perturbations succeeding, for the reason that only in the frequency of these can the result be occidental, at times during which they do not exist, the clouds are influenced mostly by the east winds of the south.[3]

The same may be said in regard to the diverse directions of low clouds during the months of July and October, remembering only that in October the normal direction participates in the polar currents.

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[1] The methods and instruments employed, together with all the necessary details used for measurement of clouds, and the photogrammetric observations, can be seen explained at length in the publication Clouds in the Philippine Archipelago, pages 40 to 82.

[2] We employ the international classification and abbreviations of the clouds.

[3] See the preceding chapter, Paragraph II.

This difference in direction disappears almost entirely by dividing the months into three groups, of which we have spoken in the preceding paragraph, and as is shown by Table XCVI c.

AVERAGE HEIGHT OF THE DIFFERENT FORMS OF CLOUDS.—TABLES XCVII A AND XCVII B.

In these tables we study the average heights of the clouds at the different hours of the day, and at different epochs of the year, during the mentioned months and groups first, and, second, for the period from April–September and October–March.

The greatest heights correspond to Group III, or rather to the months of June, July, August, and September for the high clouds and intermedials, and to Group I for the inferior clouds.

This observation gives greater heights for the high clouds from midday to 4 p. m., and belong to Groups I and III. The clouds, which depend upon the diurnal ascending currents, seem to lift themselves to greater heights not only from the effect of the daily thermic oscillation but also the yearly, as is proved by the observations of cumulus and cumulus-nimbus, which are very high from midday to 8 p. m. in all the groups and months of greatest heat, or, better said, during the period from April to September.

AVERAGE VELOCITY OF THE DIFFERENT TYPES OF CLOUDS.—TABLES XCVIII A AND XCVIII B.

In this table we give the velocity corresponding to the different forms of clouds in the various hours of the day and the different years or periods of the year. The greatest velocity is attained at the highest position of the clouds.

It is notable that in cirro-cumulus and high cumulus there is an absence of velocity, probably because the minor component of its absolute velocity is vertical. In this case we believe the motive is that cirro-cumulus and high cumulus arise from the ascending movement, while the cumulus diminishes this movement with the increase of height.

It appears that the greatest velocity of the high clouds is noted in the afternoons, and of the low clouds near midday, when the ascensional force results from greater temperature.

EXTREME HEIGHT.—TABLE XCIX.

It will not be a loss of interest to call attention to the maximum and minimum heights observed during the months and during each month.

The maximum height of the high clouds is reached in June and the greatest height in general to the months of the third group, which confirms what we have said in Table XCVII A.

EXTREME VELOCITY.—TABLE C.

In this table it will be seen that the maximum velocity of the low clouds occurs in the months of the first group and of the second group, while the maximum of the intermedials occurs in the months of the third group.

The cumulus, which abound in the months of the first group, and also in April, move with more rapidity during this time, and especially in the month of March.

There appear to be two influential causes: First, the greater nocturnal radiation, producing clearer nights and mornings during this period of the year, and giving place to greater evaporation of the sun rays during the day, consequently making more powerful currents; second, the force of the oriental current, which reaches its maximum value by this time, resulting from such components, one ascending nearly horizontally and the other attaining the greatest velocity of the low clouds.

RELATION BETWEEN THE TEMPERATURE AND THE AVERAGE HEIGHT OF THE CLOUDS.—TABLE CI.

In this table we establish the said relation, concerning which we state that the temperature of the inferior stratum only influences the height of the clouds formed by the diurnal ascending currents, as this one of the cumulus and cumulus-nimbus.

RELATION BETWEEN THE HEIGHT OF THE CLOUDS AND THE ATMOSPHERIC PRESSURE.—TABLES CII A AND CII B.

If we take into account Groups II and III we will note that the high clouds are generally observed at a greater height with low barometers during the months of the second group. The cumulus and cumulus-nimbus also rise less with high barometers during all the year, which probably results from the hindrance interposed by the general currents, which are extended by the diurnal oscillation.

RELATION BETWEEN THE HEIGHT AND DIRECTION OF THE CLOUDS.—TABLES CIII A AND CIII B.

Concerning these tables we note that during the months of the second and third group the high clouds come from the first quadrant, nearly from the east, and the result of which entirely agrees with the direct observations which we publish in the preceding paragraph.

RELATION BETWEEN VELOCITY AND HEIGHT.—TABLES CIV A AND CIV B.

It does not appear that a precise rule can be established concerning this relation. However, it will be generally verified in Manila what we have already observed as to other parts, or rather, we might say, that results are proportional to the height.

FREQUENCY OF WINDS AT DIFFERENT HEIGHTS.—TABLES CV A AND CV B.

The proportions of the clouds enable us to recognize the currents in the different strata of the atmosphere which is nearer to the earth.

From 0 to 1,000 meters of height the dominating currents of the whole year are from the second quadrant, and nearly from the south during the months of Group III. From 1,000 to 3,000 meters the currents come from the south-southeast during the months of the third group, and the first quadrant in the rest of the year, and nearly from the east during the months of Group II. There is more diversity in the currents which extend from 3,000 to 5,000 meters, probably because this is the average region of the cumulus nimbus when the electric tempests or tornadoes are forming. The currents which extend over 5,000 meters arrive normally from the first quadrant during the month of the third group. In the other months the directions change and are generally between the south and northeast.

During the period from April to September, which embraces the months called generally the typhonic season, during which the currents exceed 5,000 meters and come from the northeast, at the same time those which circulate lower than 5,000 meters have the understood direction between the south and southeast.

During the period from October to May the high and low currents come from routes comprised between the northeast and south-southeast.

TABLE XCVI A.—*Average height of clouds.*

	High clouds.			Intermediate clouds.			Low clouds.		
	Height in meters.		$\triangle Z$	Height in meters.		$\triangle Z$	Height in meters.		$\triangle Z$
	Z_1	Z_2		Z_1	Z_2		Z_1	Z_2	
January	10069.37	10072.25	−2.88	5244.72	5245.53	−0.81	1805.60	1805.11	0.49
February	12546.66	12549.13	−2.47	7036.91	7036.32	0.59	1843.65	1843.74	−0.09
March	11841.80	11841.89	−0.09	5912.58	5913.04	−0.46	2051.66	2050.89	0.77
April	10063.50	10062.57	0.93	5372.14	5372.82	−0.68	1846.14	1846.16	−0.02
May	10525.72	10525.66	0.06	6312.85	6312.89	−0.04	1597.54	1598.27	−0.73
June	13311.48	13310.91	0.57	6546.41	6546.44	−0.03	1518.71	1519.38	−0.67
July	10898.14	10896.12	2.02	6662.97	6663.43	−0.46	1439.59	1440.05	−0.46
August	12209.15	12210.23	−1.08	6254.58	6254.91	−0.33	2082.30	2082.95	−0.65
September	11508.10	11509.38	−1.28	5080.62	5080.34	0.28	1680.97	1679.98	0.99
October	11420.54	11416.61	3.93	4803.11	4803.58	−0.47	1640.83	1640.26	0.57
November	8646.51	8634.64	11.87	3819.01	3816.39	2.62	1628.71	1629.93	−1.22
December	10138.60	10141.37	−2.77	4503.28	4498.08	5.20	1807.25	1808.52	−1.27
Average	11098.30	11097.56	0.74	5629.10	5628.65	0.45	1745.24	1745.44	−0.20

TABLE XCVI B.—*Résumé of the mean direction of the clouds.*

	High clouds.		Intermediate clouds.		Low clouds.	
	Direction.	Velocity in m. p. s.	Direction.	Velocity in m. p. s.	Direction.	Velocity in m. p. s.
January	S. 49° 23′ O.	6.97	S. 45° 00′ E.	2.74	N. 78° 57′ E.	7.88
February	S. 10° 39′ E.	9.05	S. 2° 10′ E.	5.45	N. 56° 05′ E.	5.94
March	S. 22° 02′ O.	16.39	N. 75° 24′ E.	6.51	N. 65° 26′ E.	10.32
April	S. 49° 31′ O.	15.40	N. 69° 08′ E.	5.46	N. 75° 29′ E.	7.52
May	N. 46° 25′ E.	10.36	S. 67° 56′ E.	5.59	S. 67° 18′ E.	4.10
June	N. 65° 43′ E.	15.97	S. 51° 43′ E.	7.00	S. 22° 58′ E.	6.09
July	N. 60° 19′ E.	12.16	S. 61° 18′ E.	11.62	S. 42° 01′ E.	4.47
August	N. 42° 00′ E.	23.61	S. 82° 17′ E.	14.83	S. 63° 37′ O.	....
September	N. 68° 00′ E.	6.63	S. 69° 21′ O.	3.33	S. 78° 49′ O.	....
October	N. 71° 03′ E.	17.64	N. 79° 22′ E.	5.66	N. 68° 59′ O.	2.96
November	N. 29° 00′ E.	14.70	S. 73° 06′ E.	3.59	N. 73° 40′ E.	4.02
December	S. 23° 28′ E.	10.28	S. 25° 02′ E.	5.22	N. 82° 48′ E.	4.05

TABLE XCVI C.

	High clouds.			Intermediate clouds.			Low clouds.		
	Height in meters.		$\triangle Z$	Height in meters.		$\triangle Z$	Height in meters.		$\triangle Z$
	Z_1	Z_2		Z_1	Z_2		Z_1	Z_2	
Group I	11149.11	11151.16	−2.05	5674.37	5673.24	1.13	1877.04	1877.06	−0.02
Group II	10164.07	10159.87	4.20	5076.78	5076.42	0.36	1678.30	1678.65	−0.35
Group III	11981.72	11981.66	0.06	6136.14	6136.28	−0.14	1680.39	1680.59	−0.20

TABLE XCVI D.

	High clouds.		Intermediate clouds.		Low clouds.	
	Direction.	Velocity in m. p. s.	Direction.	Velocity in m. p. s.	Direction.	Velocity in m. p. s.
Group I	S. 15° 28′ O.	10.47	S. 41° 51′ E.	4.98	N. 78° 45′ E.	7.05
Group II	N. 45° 00′ E.	14.52	S. 84° 12′ E.	5.08	N. 67° 30′ E.	4.65
Group III	N. 61° 56′ E.	14.59	S. 49° 13′ E.	9.20	S. 17° 33′ O.	5.28

TABLE XCVII A.—*Mean height.*

Form.	Group I.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean height.	Cases.	Mean height.	Cases.	Mean height.	Cases.	
Cirrus	11,610.4	23	11,714.2	8	10,222.7	6	11,182.4
Cirro-stratus	10,446.7	13	12,788.2	3	12,733.5	2	11,989.5
Cirro-cumulus	6,031.5	10	....	....	5,854.1	1	5,942.8
High stratus	....	....	....	....	....	....	....
High cumulus	5,087.5	10	3,192.2	1	4,500.8	5	4,360.2
Strato-cumulus	2,247.4	1	....	....	1,858.2	3	2,052.9
Nimbus	1,725.5	3	1,626.6	2	1,565.8	11	1,639.3
Cumulus	1,849.6	47	1,742.6	15	1,849.0	45	1,813.7
Cumulo-nimbus	....	....	3,974.2	3	7,151.4	3	5,562.8
Stratus	....	....	....	....	....	....	....

Form.	Group II.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean height.	Cases.	Mean height.	Cases.	Mean height.	Cases.	
Cirrus	10,268.8	52	9,617.7	5	9,675.1	18	9,855.5
Cirro-stratus	11,219.5	4	13,112.2	1	9,101.8	1	11,144.5
Cirro-cumulus	5,310.3	25	5,776.7	1	8,342.9	5	6,476.6
High stratus	....	....	....	....	3,898.2	1	....
High cumulus	4,650.8	11	4,878.8	1	5,716.3	2	5,082.0
Strato-cumulus	....	....	....	....	2,021.7	4	....
Nimbus	873.7	4	....	....	1,536.8	2	1,205.2
Cumulus	1,618.9	49	2,071.0	5	1,703.4	19	1,765.4
Cumulo-nimbus	4,335.3	11	2,107.3	6	4,157.5	20	3,500.0
Stratus	....	....	....	....	....	....	....

Form.	Group III.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean height.	Cases.	Mean height.	Cases.	Mean height.	Cases.	
Cirrus	11,037.0	67	11,913.4	12	11,838.3	19	11,596.2
Cirro-stratus	11,355.9	13	15,314.4	1	11,744.4	3	12.971.6
Cirro-cumulus	7,125.5	30	6,028.7	11	7,847.9	10	7,000.7
High stratus	2,312.5	1	4,759.2	2	5,833.0	3	4,301.6
High cumulus	5,381.8	10	5,710.6	11	6,147.7	4	5,746.7
Strato-cumulus	1,995.1	9	....	....	1,878.4	8	1,936.7
Nimbus	1,550.4	3	....	....	1,101.5	3	1,326.0
Cumulus	1,609.1	45	1,625.3	13	1,875.5	16	1,703.3
Cumulo-nimbus	4,854.7	19	9,826.2	4	3,333.7	9	6,004.9
Stratus	1,045.4	4	1,270.8	3	1,195.4	2	1,170.7

TABLE XCVII B.

Form.	April to September.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean height.	Cases.	Mean height.	Cases.	Mean height,	Cases.	
Cirrus	10,678.1	100	11,440.4	16	11,280.7	29	11,133.1
Cirro-stratus	11,313.1	16	15,814.4	1	11,777.7	3	12,968.4
Cirro-cumulus	6,593.6	44	6,028.7	11	7,847.9	10	6,823.4
High stratus	2,312.5	1	4,759.2	2	5,833.0	3	4,301.6
High cumulus	5,233.3	11	5,739.9	11	6,147.7	4	5,707.0
Strato-cumulus	1,995.1	9	....	......	1,806.1	9	1,900.6
Nimbus	1,550.4	3	....	......	1,214.1	2	1,382.2
Cumulus	1,620.4	64	1,936.1	7	1,951.6	20	1,836.0
Cumulo-nimbus	5,186.0	23	9,826.2	4	4,350.3	17	6,154.2
Stratus	1,045.5	4	953.1	3	1,195.4	2	1,064.7

Form.	October to March.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean height.	Cases.	Mean height.	Cases.	Mean height.	Cases.	
Cirrus	11,204.5	45	11,184.0	7	9,514.7	13	10,634.4
Cirro-stratus	10,520.9	14	12,869.2	4	11,523.0	3	11,637.7
Cirro-cumulus	5,558.2	21	5,776.7	1	7,928.1	6	6,421.0
High stratus	....	......	....	......	3,898.2	1	....
High cumulus	4,881.3	23	4,185.5	2	4,848.1	7	4.638.3
Strato-cumulus	2,354.7	2	....	......	2,288.8	5	2,321.7
Nimbus	1,238.7	7	1,626.6	2	1,597.6	14	1,487.6
Cumulus	1,794.4	86	1,827.6	18	1,839.8	59	1,820.6
Cumulo-nimbus	3,257.3	10	2,107.3	6	4,043.5	15	3,136.0
Stratus	....	......	....	......	....	......	....

TABLE XCVIII A.

Mean velocities in m. p. s.

Form.	Group I.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean velocity.	Cases.	Mean velocity.	Cases.	Mean velocity.	Cases.	
Cirrus	6.44	36	12.50	9	22.71	8	9.93
Cirro-stratus	9.31	19	10.45	5	55.11	4	16.06
Cirro-cumulus	4.09	11	....	......	1.48	2	3.69
High stratus	....	......	....	......	....	......	....
High cumulus	6.79	14	6.78	2	2.72	8	5.44
Strato-cumulus	7.67	3	....	......	0.45	1	5.86
Nimbus	10.14	3	7.96	2	5.92	12	6.90
Cumulus	7.51	93	6.15	25	1.32	68	5.06
Cumulo-nimbus	....	......	7.88	5	8.63	6	8.29

Form.	Group II.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean velocity.	Cases.	Mean velocity.	Cases.	Mean velocity.	Cases.	
Cirrus	15.26	75	12.64	7	12.59	28	14.42
Cirro-stratus	6.22	9	10.41	2	26.88	2	10.04
Cirro-cumulus	4.31	32	....	......	.50	2	4.08
High stratus	....	......	....	......	18.97	1	18.97
High cumulus	3.59	13	....	......	....	......	3.59
Strato-cumulus	3.67	5	....	......	9.23	4	6.14
Nimbus	2.25	2	....	......	5.47	3	4.18
Cumulus	5.32	69	7.66	6	5.56	23	5.52
Cumulo-nimbus	4.13	10	8.87	9	6.77	27	6.61

Table XCVIII a—Continued.

Form.	Group III.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean velocity.	Cases.	Mean velocity.	Cases.	Mean velocity.	Cases.	
Cirrus	12.18	76	18.19	16	13.31	7	13.23
Cirro-stratus	23.26	10	......	......	......	......	23.26
Cirro-cumulus	9.72	25	5.02	8	......	......	8.58
High stratus	......	......	......	......	......	......	......
High cumulus	12.78	6	2.13	2	......	......	10.12
Strato-cumulus	......	......	......	......	......	......	......
Nimbus	......	......	......	......	......	......	......
Cumulus	5.52	38	......	......	......	......	5.52
Cumulo-nimbus	9.27	5	15.23	5	......	......	12.25

Table XCVIII b.

Form.	April to September.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean velocity.	Cases.	Mean velocity.	Cases.	Mean velocity.	Cases.	
Cirrus	13.21	127	15.81	21	11.43	21	13.30
Cirro-stratus	15.51	18	......	......	......	......	15.51
Cirro-cumulus	3.07	47	5.02	8	......	......	3.35
High stratus	......	......	......	......	......	......	......
High cumulus	12.61	8	2.13	2	......	......	10.71
Strato-cumulus	3.67	5	......	......	......	......	3.67
Nimbus	......	......	......	......	......	......	......
Cumulus	5.65	87	8.55	5	10.07	11	6.27
Cumulo-nimbus	6.80	9	15.23	5	7.25	10	8.74

Form.	October to March.						
	8 a. m. to 12 noon.		12 noon to 4 p. m.		4 p. m. to 8 p. m.		Average.
	Mean velocity.	Cases.	Mean velocity.	Cases.	Mean velocity.	Cases.	
Cirrus	10.35	60	11.55	11	18.59	19	12.60
Cirro-stratus	9.26	20	10.44	7	45.70	6	16.15
Cirro-cumulus	3.89	21	......	......	.99	4	3.42
High stratus	......	......	......	......	18.97	1	18.97
High cumulus	4.63	25	6.78	2	2.72	8	4.31
Strato-cumulus	7.67	3	......	......	7.48	5	7.55
Nimbus	6.99	5	7.96	2	5.83	15	6.28
Cumulus	6.84	113	6.01	26	1.33	80	4.78
Cumulo-nimbus	4.41	6	8.51	11	7.05	23	7.16

Table XCIX.—*Extreme heights.*

Month.	Ci.		Ci-S.		Ci-Cu.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	Meters.	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*
January	17,449.2	5,532.2	10,211.2	9,788.8	6,074.3	5,851.1
February	15,498.2	8,719.7	16,233.1	9,826.2	7,712.0	6,199.8
March	15,868.3	6,573.1	16,488.4	7,689.3	......	......
April	14,127.9	5,111.8	......	......	7,277.5	3,249.1
May	12,468.5	5,823.4	11,682.4	7,476.7	6,148.3	3,147.7
June	20,453.6	6,411.6	17,136.8	10,519.2	11,224.6	6,043.2
July	18,014.2	7,021.4	11,574.5	7,111.7	9,360.8	4,119.1
August	12,854.8	9,845.5	16,832.5	11,367.1	8,609.2	4,713.6
September	14,871.0	8,267.0	15,814.4	......	8,292.8	3,867.4
October	16,342.9	5,764.4	......	......	9,169.6	3,412.7
November	12,025.9	3,962.2	13,138.7	9,101.8	9,563.5	6,294.7
December	15,785.7	5,732.9	14,787.0	6,878.7	5,482.1	4,979.9

TABLE XCIX.—*Extreme heights*—Continued.

Month.	A-S.		A-Cu.		S-Cu.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	Meters.	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*
January	....	....	3,988.3	3,743.6	2,247.4	2,133.7
February	....	....	....	....	1,461.9	....
March	....	....	7,527.2	3,169.4	....	....
April	....	....	....	....	1,881.1	1,384.5
May	....	....	3,778.0	3,715.6	....	....
June	....	....	5,232.5	3,973.3	....	....
July	7,086.1	3,272.0	7,639.9	5,000.4	1,875.7	1,384.4
August	7,141.0	3,212.5	7.644.9	3,874.4	3,883.3	1,450.6
September	5,244.3	4,274.2	8,045.2	2,908.7	2,193.8	1,338.3
October	3,898.2	....	6,593.9	3,804.8	1,408.8	....
November	....	....	5,720.7	3,757.8	3,013.9	2,502.2
December	....	....	5,600.4	3,492.2	2,254.9	....

Month.	N.		Cu.		Cu-N.		S.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	Meters.	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*	*Meters.*
January	1,950.8	1,030.7	3,484.0	813.3	....	....	....	....
February	1,620.3	1,512.2	3,140.0	1,014.0	....	....	....	....
March	2,047.6	1,382.4	3,820.8	1,146.0	10,135.3	7,591.8	....	....
April	....	....	2,793.2	1,264.5	6,797.9	2,976.4	....	....
May	....	....	2,740.6	870.3	9,724.5	3,011.0	....	....
June	....	....	3,283.3	798.7	5,051.1	885.8	1,184.3	948.8
July	923.3	....	3,931.1	528.8	12,859.3	2,001.7	1,400.7	990.2
August	1,982.3	944.8	3,546.9	1,171.0	8,781.8	4,558.9	1,581.2	611.6
September	1,724.1	....	4,448.7	842.9	7,751.1	1,424.8	1,356.7	587.7
October	988.9	836.0	2,742.2	1,413.7	7,274.1	2,042.5	....	....
November	2,294.3	1,410.2	2,503.9	622.2	6,359.8	1,140.4	....	....
December	1,876.8	1,503.6	2,918.8	1,069.7	4,779.2	3,286.3	....	....

TABLE C.—*Extreme velocities.*

Month.	Ci.		Ci-S.		Ci-Cu.		A-Cu.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	M.p.s.	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*
January	8.77	2.35	18.34	....	4.55	1.48	2.18	....
February	11.60	2.70	25.50	....	9.24	1.66	....	....
March	20.56	7.15	84.71	6.39	....	....	9.54	2.59
April	70.48	2.69	....	....	9.42	1.50	....	....
May	46.52	2.87	8.59	4.20	7.88	1.82	13.10	....
June	64.93	1.02	70.51	....	17.39	2.34	5.98	....
July	42.13	3.74	15.11	7.02	37.87	2.49	16.12	1.42
August	41.66	18.30	10.86	....	....	....	16.23	....
September	12.44	1.96	....	....	3.33	....	....	....
October	71.02	2.56	....	....	5.84	1.10	....	....
November	26.88	1.51	10.41	8.90	7.50	0.50	4.43	1.12
December	36.34	2.46	9.13	3.51	2.82	....	15.01	1.21

Month.	S-Cu.		N.		Cu.		Cu-N.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	M.p.s.	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*	*M.p.s.*
January	....	....	11.54	1.85	28.85	0.80	....	....
February	0.16	....	11.58	....	22.25	0.16	....	....
March	....	....	7.35	1.30	33.72	1.69	13.25	10.29
April	4.13	3.36	....	....	22.33	0.88	12.14	5.00
May	....	....	....	....	8.06	0.63	10.51	0.84
June	....	....	....	....	10.19	1.95	5.85	....
July	....	....	....	....	11.60	0.75	20.29	7.64
August	....	....	....	....	....	....	13.44	....
September	....	....	....	....	....	....	....	....
October	....	....	2.25	....	6.50	....	13.09	1.88
November	13.72	6.71	6.71	3.00	6.40	0.50	31.04	1.02
December	....	....	3.24	2.12	14.52	0.45	8.89	2.36

TABLE CI.—*Mean heights according to varying temperatures.*

Temperature (centigrade).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
17° to 27°......	9,665	28	11,125	10	6,441	13	7,144	1	4,774	8
27° to 37°......	10,813	275	11,323	54	6,336	105	4,349	6	5,068	62

Temperature (centigrade).	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
17° to 27°......	2,316	6	....	....	1,637	41	3,325	4	....	....
27° to 37°......	1,900	22	1,535	37	1,765	321	5,046	92	1.038	10

TABLE CII A.—*Mean heights according to varying atmospheric pressure.*

	Pressure in millimeters.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
		Height.	Cases.	Height.	Cases.	Height.	Cases.	Height.	Cases.	Height.	Cases.
		Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
Group I	750 to 756 .	....	.....	....	.....	....	.....	....	.....	....	.....
	756 to 760 .	11,014.4	11	13,264.4	9	5,883.8	2	....	.....	3,479.8	7
	760 to 765 .	11 206.1	42	10,710.2	19	6,035.7	11	....	.....	5,598.9	16
Group II ...	750 to 756 .	12,711.8	3	....	.....	7,473.1	2	....	.....	....	.....
	756 to 760 .	10, 70.1	75	10,422.4	12	5,690.9	26	3,900.1	1	4,782.0	7
	760 to 765 .	9,312.6	37	11,487.2	1	5,523.3	12	....	.....	4,715.7	11
Group III ..	750 to 756 .	11,392.9	14	13,968.9	2	7,218.1	11	....	.....	6,610.8	3
	756 to 760 .	11,290.6	112	12,072.9	21	6,919.9	51	4 889.7	6	5,424.6	26
	760 to 765 .	9,795.7	9	....	.....	5,532.3	3	....	.....	....	.....

	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Cases.	Height.	Cases.	Height.	Cases.	Height.	Cases.	Height.	Cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
Group I	....	....	....	....	....	....	....	....	....	....
	....	....	1,464.1	9	1,953.7	45	8,870.7	4	....	....
	2,028.9	1	1,728.1	14	1,816.4	145	4.084.8	7	....	....
Group II ...	....	....	....	....	2,027.2	4	9,658.8	2	....	....
	1,909.5	8	1,409.9	1	1,855.5	51	1,362.5	33	....	....
	2,998.5	1	1,350.6	7	1,511.7	47	2,544.1	15	....	....
Group III ..	1,828.7	4	1,340.6	2	1,343.4	9	5,195.4	4	1,096.4	2
	1,991.7	11	1,393.2	4	1,717.4	60	5,609.9	27	1,023.0	8
	....	....	....	....	1,436.7	1	5,906.9	4	....	....

TABLE CII B.—*Mean heights according to varying pressures.*

APRIL TO SEPTEMBER.

Pressure (mm.).	Ci.		Ci.S.		Ci.Cu.		A.S.		A.Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
750 to 756......	11,336.4	16	13,968.9	2	7,218.1	11	....	....	6,610.8	3
756 to 760......	11,121.2	164	11,512.3	29	6,675.4	63	4,889.7	6	5,304.8	28
760 to 765......	9,507.9	28	....	....	5,242.3	13	....	....	....	....

TABLE CII B.—*Mean heights according to varying pressures*—Continued.

APRIL TO SEPTEMBER—Continued.

Pressure (mm.).	S. Cu.		N.		Cu.		Cu. N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
750 to 756......	1,828.7	4	1,340.6	2	1,506.9	12	6,683.2	6	1,096.4	2
756 to 760......	1,906.6	16	1,393.2	4	1,791.5	100	5,753.4	39	1,023.0	8
760 to 765......	....	....	....	....	1,519.8	23	5,906.9	4	....	....

OCTOBER TO MARCH.

Pressure (mm.).	Ci.		Ci. S.		Ci. Cu.		A. S.		A. Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
750 to 756......	1,634.4	1	....	....	7,473.1	2	....	....	....	....
756 to 760......	10,732.9	34	12,624.9	13	5,755.9	16	3,900.1	1	4,105.0	12
760 to 765......	10,619.4	60	10,749.0	20	6,239.8	13	....	....	5,239.2	27

Pressure (mm.).	S. Cu.		N.		Cu.		Cu. N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
750 to 756......	....	....	....	....	2,117.0	1	....	....	....	....
756 to 760......	2,226.7	3	1,458.7	10	1,900.7	56	4,258.2	25	....	....
760 to 765......	2,222.8	5	1,602.3	21	1,770.1	170	3,034.3	22	....	....

TABLE CIII A.—*Mean height and frequency at different directions.*

GROUP I.

Direction.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N	....	....	....	....	....	....	....	....	....	....
NNE	11,573.3	2	....	....	....	....	....	....	3,172.6	2
NE	....	....	....	....	....	....	....	....	7,259.5	4
ENE	10,468.1	7	....	....	....	....	....	....	5,596.1	4
E	12,053.7	3	16,183.0	2	....	....	....	....	3,567.0	7
ESE	....	....	10,383.3	4	5,256.6	5	....	....	4,883.1	1
SE	10,143.6	4	10,257.6	7	....	....	....	....	4,424.8	2
SSE	11,837.4	9	....	....	....	....	....	....	....	....
S	11,003.2	5	....	....	7,036.9	4	....	....	....	....
SSW	....	....	10,512.4	6	....	....	....	....	....	....
SW	11,018.7	7	9,987.7	2	5,981.1	2	....	....	3,564.0	2
WSW	13,614.4	7	13,513.9	2	....	....	....	....	5,172.0	2
W	5,763.8	4	11,653.9	3	5,883.8	2	....	....	....	....
WNW	....	....	16,065.2	2	....	....	....	....	....	....
NW	12,989.1	5	....	....	....	....	....	....	....	....
NNW	....	....	....	....	....	....	....	....	....	....
Mean direction	S. 8° 51′ W.		S. 1° 1′ E.		S. 9° 20′ E.		....		N. 80° 31′ E.	

TABLE CIII A.—*Mean height and frequency at different directions*—Continued.

GROUP I—Continued.

Direction.	S.-Cu.		N.		Cu.		Cu.-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N			1,546.3	1	1,596.8	17				
NNE			2,350.0	3	1,889.3	22	4,189.2	2		
NE					2,028.8	24				
ENE	1,462.1	1	1,587.0	4	2,177.2	46				
E	2,199.4	2	2,129.7	4	1,746.9	34				
ESE			1,382.4	1	1,861.0	18				
SE			1,579.4	2	1,691.3	13				
SSE	2,254.6	1			1,748.1	3				
S					1,620.2	2	3,849.3	2		
SSW										
SW			1,112.6	2	1,935.9	2				
WSW					2,714.3	2	8,853.0	4		
W										
WNW							4,172.3	3		
NW					1,659.6	3				
NNW										
Mean direction	S. 80° 42′ E.		N. 64° 46′ E.		N. 67° 33′ E.		S. 84° 38′ W.			

GROUP II.

Direction.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N	9,399.0	11			7,260.2	4			5,607.2	2
NNE	9,964.9	13			5,707.8	6				
NE	9,216.2	12	7,972.0	3	6,679.0	3			3,798.8	1
ENE	11,321.5	17	12,403.0	4	5,481.5	13				
E	9,409.1	10	11,019.6	3	3,975.3	5				
ESE	13,084.7	11					3,900.1	1	3,908.7	4
SE	6,597.9	5			5,776.7	1			4,878.8	1
SSE										
S	9,796.8	3			6,429.0	4			5,004.7	5
SSW	11,512.0	3			6,446.2	2				
SW	10,180.6	9	9,241.3	2	5,071.3	2				
WSW										
W	8,164.1	6							3,746.6	2
WNW	9,453.6	7								
NW										
NNW	14,186.1	2	11,487.2	1					5,717.8	2
Mean direction	N. 54° 44′ E.		N. 65° 45′ E.		N. 66° 30′ E.		S. 67° 30′ E.		S. 41° 08′ E.	

Direction.	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N					1,481.2	1				
NNE	2,254.0	3	2,261.6	2	1,476.3	4	1,614.5	4		
NE	1,610.9	3			1,820.5	12	2,472.5	6		
ENE					1,574.7	20	4,430.6	8		
E			1,409.9	1	1,504.2	15	4,646.0	2		
ESE	2,635.8	2			2,650.1	14	2,428.3	4		
SE					1,611.8	12	4,948.0	4		
SSE					1,303.6	3	3,228.6	4		
S					2,725.4	2	9,658.8	2		
SSW					1,904.2	5	4,524.7	5		
SW			874.4	2	782.0	2	5,640.8	3		
WSW			944.4	1	2,117.0	1				
W					2,918.2	7	4,104.1	2		
WNW										
NW	1,408.2	1			1,483.8	1	7,189.3	2		
NNW					864.8	2	2,732.1	2		
Mean direction	N. 42° 22′ E.		N. 11° 15′ E.		S. 88° 14′ E.		S. 80° 24′ E.			

TABLE CIII A.—*Mean height and frequency of different directions*—Continued.

GROUP III.

Direction.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N	10,526.9	3			6,258.5	3			6,251.0	1
NNE	12,545.3	28	12,800.9	4	5,980.0	4				
NE	10,221.2	12			8,582.2	10			7,689.0	2
ENE	9,886.0	23	17,132.7	2	7,707.2	6	7,144.3	1	5,781.4	6
E	10,882.2	26	10,920.0	3	5,059.6	4			7,210.0	3
ESE	9,557.3	5			7,198.7	5			4,650.5	3
SE	9,511.4	9	9,926.9	5	6,477.0	4	2,312.5	1		
SSE										
S										
SSW										
SW	13,124.0	3	12,042.0	2	7,550.6	5	7,085.5	1	3,948.0	2
WSW	11,941.8	6			5,967.6	8	4,282.1	1	6,056.1	3
W	18,080.2	3			7,175.3	4	3,268.8	1	4,454.5	1
WNW	11,232.4	2								
NW			15,817.5	1	5,253.8	1			4,717.2	2
NNW										
Mean direction	N. 62° 12′ E.		N. 88° 23′ E.		N. 61° 23′ E.		S. 35° 15′ W.		N. 68° 30′ E.	

Direction.	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Num ber of eases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N										
NNE										
NE					2,829.9	1	4,015.8	1		
ENE	1,338.3	1			837.8	6	3,189.8	2		
E					1,491.5	7	6,032.0	8	1,181.3	1
ESE					1,524.1	10				
SE	1,927.2	4			1,684.2	10	2,238.6	3		
SSE					2,432.3	5			1,193.7	2
S							12,302.1	3		
SSW	1,706.2	2			1,800.9	7	2,001.7	1		
SW					1,183.0	7	12,613.5	2		
WSW	2,096.1	2	1,724.4	1	1,920.3	6	3,759.7	8		
W	2,222.4	3	1,554.3	3	1,371.7	4	4,913.4	1	927.0	3
WNW	1,671.8	1			1,481.5	3	6,148.2	2		
NW							4,556.8	1		
NNW					2,834.3	2				
Mean direction	S. 30° 46′ W.		S. 84° 25′ W.		S. 66° 10′ E.		S. 0° 30′ W.		S. 18° 21′ E.	

TABLE CIII B.—*Mean height and frequency at different directions.*

FROM APRIL TO SEPTEMBER.

Direction.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N	10,234.6	9			6,258.5	3			6,251.0	1
NNE	12,385.5	34	12,800.9	4	6,493.5	7				
NE	10,131.0	21	7,972.0	3	8,582.2	10			7,689.0	2
ENE	9,947.4	32	14,401.5	4	6,718.1	14	7,144.3	1	5,781.4	6
E	10,758.1	32	10,969.9	6	4,457.2	9			7,210.0	3
ESE	10,312.8	9			7,198.7	5			4,650.5	3
SE	9,204.5	12	9,926.9	5	6,477.0	4	2,312.5	1		
SSE										
S	9,796.8	3			3,467.1	2				
SSW	11,512.0	3			6,446.2	2				
SW	11,902.4	10	12,042.0	2	6,842.3	7	7,085.5	1	3,948.0	2
WSW	11,941.8	6			5,967.6	8	4,282.1	1	6,056.1	3
W	11,469.5	9			7,175.3	4	3,268.8	1	3,982.6	3
WNW	9,848.9	9								
NW			15,817.5	1	5,253.8	1			4,117.2	2
NNW										
Mean direction	N. 59° 44′ E.		N. 65° 16′ E.		N. 74° 32′ E.		S. 35° 53′ W.		N. 59° 41′ E.	

TABLE CIII B.—*Mean height and frequency at different directions*—Continued.

FROM APRIL TO SEPTEMBER—Continued.

Direction.	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N										
NNE	1,881.7	2								
NE	1,610.9	3			2,088.4	5	1,015.8	1		
ENE	1,338.3	1			1,364.6	25	5,350.2	7		
E					1,579.6	19	6,032.0	8	1,181.3	1
ESE					2,232.7	23				
SE	1,927.2	4			1,772.7	18	4,686.1	5		
SSE					2,432.3	5			1,193.7	2
S					2,725.4	2	11,244.8	5		
SSW	1,706.2	2			1,800.9	7	2,001.7	1		
SW					1,093.9	9	8,429.9	5		
WSW	2,096.1	2	1,721.4	1	1,920.3	6	3,759.7	8		
W	2,222.4	3	1,551.3	3	1,892.9	9	4,373.9	3	927.0	3
WNW	1,671.8	1			1,481.5	3	6,148.2	2		
NW							4,556.8	1		
NNW					2,834.3	2				
Mean direction	S. 8° 12′ E.		S. 84° 26′ W.		S. 85° 52′ E.		S. 9° 22′ E.		S. 33° 82′ W.	

FROM OCTOBER TO MARCH.

Direction.	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N	8,571.5	5			7,260.2	4			5,607.2	2
NNE	9,205.7	9			4,237.6	3			3,172.6	2
NE	6,499.1	3			6,679.0	3			6,567.4	5
ENE	11,653.4	15	13,131.2	2	4,689.8	5			5,596.1	4
E	9,847.0	7	16,183.0	2					3,567.0	7
ESE	11,128.9	7	10,383.3	4	5,256.6	5	3,900.1	1	4,103.6	5
SE	8,118.7	6	10,257.6	7	5,776.7	1			4,576.2	3
SSE	11,837.4	9								
S	11,003.2	5			7,821.5	6			5,004.7	5
SSW			10,512.4	6						
SW	9,900.4	9	9,614.5	4	5,981.1	2			3,564.0	2
WSW	13,614.4	7	13,513.9	2					5,172.0	2
W	5,763.8	1	11,653.9	3	5,883.8	2				
WNW			16,065.2	2						
NW	12,989.1	5								
NNW	14,186.1	2	11,487.2	1					5,717.8	2
Mean direction	S. 82° 02′ E.		S. 1° 15′ E.		N. 89° 32′ E.		S. 67° 30′ E.		S. 88° 32′ E.	

Direction.	S-Cu.		N.		Cu.		Cu-N.		S.	
	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.	Height.	Number of cases.
	Meters.		*Meters.*		*Meters.*		*Meters.*		*Meters.*	
N			1,516.3	1	1,590.4	18				
NNE	2,998.5	1	2,314.6	5	1,825.8	26	2,472.8	6		
NE					1,966.4	32	2,472.5	6		
ENE	1,462.1	1	1,587.0	4	2,182.0	47	1,457.8	3		
E	2,199.4	2	1,985.7	5	1,686.0	37	4,646.0	2		
ESE	2,635.8	2	1,382.4	1	1,815.2	19	2,428.3	4		
SE			1,579.4	2	1,544.9	17	1,538.6	2		
SSE	2,254.6	1			1,525.9	6	3,228.6	4		
S					1,620.2	2	3,849.3	2		
SSW					1,904.2	5	4,524.7	5		
SW			993.5	4	1,935.9	2				
WSW			941.4	1	2,515.2	3	8,853.0	4		
W					2,189.3	2				
WNW							4,172.3	3		
NW	1,408.2	1			1,615.9	4	7,189.3	2		
NNW					864.8	2	2,732.1	2		
Mean direction	N. 89° 36′ E.		N. 76° 53′ E.		N. 68° 11′ E.		N. 89° 03′ E.			

TABLE CIV A.—*Mean velocity and frequency at different altitudes.*

GROUP I.

Height (in meters).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.
500 to 1,000										
1,000 to 1,500										
1,500 to 2,000										
2,000 to 2,500										
2,500 to 3,000										
3,000 to 3,500									3.99	7
3,500 to 4,000									3.82	5
4,000 to 4,500									2.93	1
4,500 to 5,000					2.82	1			6.38	3
5,000 to 6,500					2.82	4				
5,500 to 6,000	4.50	5			2.50	3			8.86	2
6,000 to 6,500	8.77	1			3.11	2			2.70	2
6,500 to 7,000	13.39	2	3.51	2	1.66	1			9.54	1
7,000 to 7,500									9.54	2
7,500 to 8,000	5.77	1	8.59	2	9.24	2			9.54	1
8,000 to 8,500	6.77	1	6.15	1						
8,500 to 9,000	20.64	2	10.79	1						
9,000 to 9,500	26.85	2	10.79	2						
9,500 to 10,000	2.35	2	17.84	3						
10,000 to 10,500	9.68	2	15.53	4						
10,500 to 11,000	8.26	3								
11,000 to 11,500	9.28	8								
11,500 to 12,000	12.29	4								
12,000 to 12,500	4.92	2								
12,500 to 13,000	17.42	4	8.04	4						
13,000 to 13,500	13.01	2	8.70	1						
13,500 to 14,000			8.70	1						
14,000 to 14,500	11.76	2								
14,500 to 15,000			9.13	2						
15,000 to 15,500	2.77	3								
15,500 to 16,000	7.12	4	84.71	1						
16,000 to 16,500			29.68	4						
16,500 to 17,000										
17,000 to 17,500	2.97	2								
17,500 to 18,000	17.36	1								
18,000 to 18,500										
18,500 to 19,000										
19,000 to 19,500										
19,500 to 20,000										
20,000 to 20,500										

Height (in meters).	S-Cu.		N.		Cu.		Cu-N.		Mean velocity, m. p. s.
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
500 to 1,000			5.91	6	11.20	3			11.20
1,000 to 1,500	0.16	1	7.93	10	6.49	28			6.27
1,500 to 2,000			1.30	2	7.06	79			7.17
2,000 to 2,500	7.76	3			7.79	39			7.49
2,500 to 3,000					9.21	20			9.21
3,000 to 3,500					7.40	5	8.89	1	5.68
3,500 to 4,000					14.54	2	2.36	2	5.88
4,000 to 4,500							7.20	3	6.13
4,500 to 5,000							8.89	1	6.17
5,000 to 5,500									2.82
5,500 to 6,000									4.77
6,000 to 6,500									4.08
6,500 to 7,000									7.50
7,000 to 7,500									9.54
7,500 to 8,000							13.25	2	9.68
8,000 to 8,500									5.93
8,500 to 9,000									17.36
9,000 to 9,500									18.82
9,500 to 10,000									11.64
10,000 to 10,500							10.29	2	12.76
10,500 to 11,000									8.26
11,000 to 11,500									9.28
11,500 to 12,000									12.29
12,000 to 12,500									4.92
12,500 to 13,000									12.73
13,000 to 13,500									11.57
13,500 to 14,000									8.70
14,000 to 14,500									11.76
14,500 to 15,000									9.13

TABLE CIV A.—*Mean velocity and frequency at different altitudes*—Continued.

GROUP I—Continued.

Height (in meters).	S-Cu.		N.		Cu.		Cu-N.		Mean velocity, m. p. s.
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
15,000 to 15,500									2.77
15,500 to 16,000									22.64
16,000 to 16,500									29.68
16,500 to 17,000									
17,000 to 17,500									2.97
17,500 to 18,000									17.36
18,000 to 18,500									
18,500 to 19,000									
19,000 to 19,500									
19,500 to 20,000									
20,000 to 20,500									

GROUP II.

Height (in meters).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Velocity	Number of cases.	Velocity.	Number of cases.	Velocity.	Number of cases.	Velocity.	Number of cases.	Velocity.	Number of cases.
500 to 1,000										
1,000 to 1,500										
1,500 to 2,000										
2,000 to 2,500										
2,500 to 3,000										
3,000 to 3,500					3.77	4				
3,500 to 4,000	5.91	1			4.26	3	18.97	1	5.91	5
4,000 to 4,500	4.42	2			2.55	5			1.12	1
4,500 to 5,000	26.88	1			1.10	1			1.41	3
5,000 to 5,500	16.11	2			7.17	3			2.44	3
5,500 to 6,000	12.32	1			4.09	2			4.43	1
6,000 to 6,500	12.66	2			3.47	10				
6,500 to 7,000	2.56	2								
7,000 to 7,500	9.32	6	4.20	1	9.42	3				
7,500 to 8,000	10.17	9								
8,000 to 8,500	27.40	4	4.20	2	3.57	1				
8,500 to 9,000	11.95	8								
9,000 to 9,500	10.62	1	26.88	2	50	2				
9,500 to 10,000	9.57	4								
10,000 to 10,500	27.97	6	8.59	1						
10,500 to 11,000	9.67	9								
11,000 to 11,500	29.28	9	8.69	3						
11,500 to 12,000	17.73	9	1.34	2						
12,000 to 12,500	11.10	17								
12,500 to 13,000										
13,000 to 13,500	11.34	2	10.11	2						
13,500 to 14,000	6.96	3								
14,000 to 14,500	11.40	1								
14,500 to 15,000										
15,000 to 15,500	13.86	1								
15,500 to 16,000	16.50	1								
16,000 to 16,500										
16,500 to 17,000										
17,000 to 17,500										
17,500 to 18,000										
18,000 to 18,500										
18,500 to 19,000										
19,000 to 19,500										
19,500 to 20,000										
20,000 to 20,500										

TABLE CIV A.—*Mean velocity and frequency at different altitudes*—Continued.

GROUP II—Continued.

Height (in meters).	S-Cu.		N.		Cu.		Cu-N.		Mean velocity.
	Velocity.	Number of cases.	Velocity.	Number of cases.	Velocity.	Number of cases.	Velocity.	Number of cases.	
500 to 1,000			2.25	2	2.64	6			2.54
1,000 to 1,500	3.17	2	3.00	1	4.27	31	2.70	3	4.05
1,500 to 2,000	3.75	4			6.05	37	2.90	7	5.40
2,000 to 2,500	13.62	1	6.71	2	8.50	15	9.77	5	8.84
2,500 to 3,000	10.17	2			4.63	9	11.51	10	8.43
3,000 to 3,500							4.83	2	4.12
3,500 to 4,000									6.72
4,000 to 4,500							10.42	5	5.75
4,500 to 5,000							1.98	1	5.71
5,000 to 5,500									7.63
5,500 to 6,000							1.98	1	5.38
6,000 to 6,500							1.98	1	4.77
6,500 to 7,000							5.00	2	3.78
7,000 to 7,500							2.98	2	7.86
7,500 to 8,000							10.51	1	10.20
8,000 to 8,500							2.61	2	14.09
8,500 to 9,000							10.51	2	11.66
9,000 to 9,500									12.15
9,500 to 10,000							0.84	2	6.66
10,000 to 10,500									25.20
10,500 to 11,000									9.67
11,000 to 11,500									24.13
11,500 to 12,000									15.30
12,000 to 12,500									11.10
12,500 to 13,000									
13,000 to 13,500									10.87
13,500 to 14,000									6.96
14,000 to 14,500									11.40
14.500 to 15,000									
15,000 to 15,500									13.86
15,500 to 16,000									16.50
16,000 to 16,500									
16,500 to 17,000									
17,000 to 17,500									
17,500 to 18,000									
18,000 to 18,500									
18,500 to 19,000									
19,000 to 19,500									
19,500 to 20,000									
20,000 to 20,500									

GROUP III.

Height (in meters).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.
500 to 1,000										
1,000 to 1,500										
1,500 to 2,000										
2,000 to 2,500										
2,500 to 3,000									11.05	3
3,000 to 3,500									16.23	1
3,500 to 4,000					3.33	2			1.42	1
4,000 to 4,500					21.16	3			1.42	2
4,500 to 5,000										
5,000 to 5,500									16.12	2
5,500 to 6,000					3.83	4				
6,000 to 6,500					8.35	5				
6,500 to 7,000	2.21	2			7.38	4				
7.000 to 7,500	11.83	6	15.11	2	10.88	4				
7,500 to 8,000	14.28	6			8.37	3				
8,000 to 8,500	12.40	7								
8,500 to 9,000	30.50	5			3.37	2				
9,000 to 9,500	7.22	8			3.80	4				
9,500 to 10,000	14.24	6								
10,000 to 10,500	6.04	10			7.98	1				
10,500 to 11,000	9.47	4	7.02	2						
11,000 to 11,500	7.08	7	10.86	2	7.98	1				
11,500 to 12,000	12.91	1								
12,000 to 12,500	22.81	8								

TABLE CIV A.—*Mean velocity and frequency at different altitudes*—Continued.

GROUP III—Continued.

Height (in meters).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.
12,500 to 13,000	14.80	11	....	......	....	......	....	......	....	......
13,000 to 13,500	10.63	3	....	......	....	......	....	......	....	......
13,500 to 14,000	5.88	1	70.51	1	....	......	....	......	....	......
14,000 to 14,500	8.82	5	....	......	....	......	....	......	....	......
14,500 to 15,000	37.19	2	70.51	1	....	......	....	......	....	......
15,000 to 15,500	....	......	....	......	....	......	....	......	....	......
15,500 to 16,000	....	......	....	......	....	......	....	......	....	......
16,000 to 16,500	....	......	....	......	....	......	....	......	....	......
16,500 to 17,000	....	......	....	......	....	......	....	......	....	......
17,000 to 17,500	....	......	12.80	2	....	......	....	......	....	......
17,500 to 18,000	25.02	1	....	......	....	......	....	......	....	......
18,000 to 18,500	25.02	1	....	......	....	......	....	......	....	......
18,500 to 19,000	13.22	2	....	......	....	......	....	......	....	......
19,000 to 19,500	1.51	1	....	......	....	......	....	......	....	......
19,500 to 20,000	....	......	....	......	....	......	....	......	....	......
20,000 to 20,500	14.05	2	....	......	....	......	....	......	....	......

Height (in meters).	S.-Cu.		N.		Cu.		Cu.-N.		Mean velocity, m. p. s.
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
500 to 1,000	....	......	....	......	....	......	....	......	....
1,000 to 1,500	....	......	....	......	....	......	....	......	....
1,500 to 2,000	....	......	....	......	....	......	....	......	....
2,000 to 2,500	....	......	....	......	....	......	....	......	....
2,500 to 3,000	....	......	....	......	....	......	....	......	11.05
3,000 to 3,500	....	......	....	......	....	......	....	......	16.23
3,500 to 4,000	....	......	....	......	....	......	....	......	2.69
4,000 to 4,500	....	......	....	......	....	......	7.75	1	12.34
4,500 to 5,000	....	......	....	......	....	......	6.85	3	6.85
5,000 to 5,500	....	......	....	......	4.02	7	22.15	1	8.25
5,500 to 6,000	....	......	....	......	6.02	16	....	......	5.58
6,000 to 6,500	....	......	....	......	6.48	6	....	......	7.33
6,500 to 7,000	....	......	....	......	4.72	4	....	......	5.28
7,000 to 7,500	....	......	....	......	7.12	3	....	......	11.07
7,500 to 8,000	....	......	....	......	7.07	2	....	......	11.36
8,000 to 8,500	....	......	....	......	....	......	....	......	12.40
8,500 to 9,000	....	......	....	......	....	......	13.44	2	20.68
9,000 to 9,500	....	......	....	......	....	......	....	......	6.08
9,500 to 10,000	....	......	....	......	....	......	....	......	14.24
10,000 to 10,500	....	......	....	......	....	......	....	......	6.22
10,500 to 11,000	....	......	....	......	....	......	....	......	8.65
11,000 to 11,500	....	......	....	......	....	......	....	......	7.93
11,500 to 12,000	....	......	....	......	....	......	20.29	1	16.60
12,000 to 12,500	....	......	....	......	....	......	20.29	1	22.53
12,500 to 13,000	....	......	....	......	....	......	11.86	3	14.17
13,000 to 13,500	....	......	....	......	....	......	....	......	10.63
13,500 to 14,000	....	......	....	......	....	......	....	......	38.19
14,000 to 14,500	....	......	....	......	....	......	....	......	8.82
14,500 to 15,000	....	......	....	......	....	......	....	......	48.30
15,000 to 15,500	....	......	....	......	....	......	....	......	....
15,500 to 16,000	....	......	....	......	....	......	....	......	....
16,000 to 16,500	....	......	....	......	....	......	....	......	....
16,500 to 17,000	....	......	....	......	....	......	....	......	....
17,000 to 17,500	....	......	....	......	....	......	....	......	12.80
17,500 to 18,000	....	......	....	......	....	......	....	......	25.02
18,000 to 18,500	....	......	....	......	....	......	....	......	25.02
18,500 to 19,000	....	......	....	......	....	......	....	......	13.22
19,000 to 19,500	....	......	....	......	....	......	....	......	1.51
19,500 to 20,000	....	......	....	......	....	......	....	......	....
20,000 to 20,500	....	......	....	......	....	......	....	......	14.05

TABLE CIV B.—*Mean velocity and frequency at different altitudes.*

FROM APRIL TO SEPTEMBER.

Height (in meters).	Ci.		Ci.-S.		Ci.-Cu.		A.-S.		A.-Cu.	
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.
500 to 1,000										
1,000 to 1,500										
1,500 to 2,000										
2,000 to 2,500										
2,500 to 3,000										
3,000 to 3,500					3.07	3				
3,500 to 4,000					3.33	2			11.87	5
4,000 to 4,500	2.93	1			10.73	7			16.28	1
4.500 to 5,000									1.42	1
5,000 to 5,500	16.11	2			7.17	3			1.42	2
5.500 to 6,000	12.32	1			3.91	6				
6,000 to 6,500	8.85	1			5.35	12			16.12	2
6,500 to 7,000	2.21	2			7.38	4				
7 000 to 7,500	10.25	9	11.47	3	10.25	7				
7,500 to 8,000	11.68	13			8.37	3				
8,000 to 8,500	11.29	9	4.20	2						
8,500 to 9.000	20.32	12			3.37	2				
9,000 to 9,500	7.58	9			3.80	4				
9,500 to 10.000	11.05	9								
10,000 to 10,500	14.11	15	8.59	1	7.98	1				
10,500 to 11.000	8.64	10	7.02	2						
11,000 to 11,500	16.08	13	9.73	4	7.98	1				
11,500 to 12,000	17.25	10	4.34	2						
12,000 to 12,500	15.20	21								
12,500 to 13,000	14.80	11								
13,000 to 13,500	10.91	5								
13,500 to 14,000	4.30	3	70.51	1						
14,000 to 14,500	8.83	7								
14,500 to 15,000	37.19	2	70.51	1						
15,000 to 15,500										
15,500 to 16,000										
16,000 to 16,500										
16.500 to 17,000										
17,000 to 17,500			12.80	2						
17,500 to 18,000	25.02	1								
18,000 to 18,500	25.02	1								
18,500 to 19,000	13.22	2								
19,000 to 19,500	1.51	1								
19.500 to 20,000										
20,000 to 20,500	14.05	2								

Height (in meters).	S.-Cu.		N.		Cu.		Cu.-N.		Mean velocity, m. p. s.
	Velocity. m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
500 to 1,000					3.63	9			3.63
1,000 to 1,500	3.36	1			6.13	31			6.04
1,500 to 2,000	3.75	4			6.47	36			6.20
2,000 to 2,500					8.91	14			8.91
2,500 to 3,000					5.37	11	5.00	1	5.34
3,000 to 3,500					7.07	2	4.83	2	4.72
3,500 to 4,000									9 43
4,000 to 4,500							10.68	3	11 36
4,500 to 5,000							6.85	3	5.49
5,000 to 5,500							22.15	1	9.84
5,500 to 6,000									5.11
6,000 to 6,500									7.02
6,500 to 7,000							5.00	2	5.49
7,000 to 7,500									10.44
7,500 to 8,000									11.06
8,000 to 8,500							2.61	2	8.86
8,500 to 9,000							11.68	5	16.26
9,000 to 9,500									6.41
9,500 to 10,000							84	2	9.19
10,000 to 10,500									13.42
10,500 to 11,000									8.37
11,000 to 11,500									14.22
11,500 to 12,000							20.29	1	15.50
12,000 to 12,500							20.29	1	15.43
12,500 to 13,000							11.86	3	14.17
13,000 to 13,500									10.91
13,500 to 14,000									20.85
14,000 to 14,500									8.83

TABLE CIV B.—*Mean velocity and frequency at different altitudes*—Continued.

FROM APRIL TO SEPTEMBER—Continued.

Height (in meters).	S.-Cu.		N.		Cu.		Cu.-N.		Mean velocity, m. p. s.
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
14,500 to 15,000									48.30
15,000 to 15,500									
15,500 to 16,000									
16,000 to 16,500									
16,500 to 17,000									
17,000 to 17,500									12.80
17,500 to 18,000									25.02
18,000 to 18,500									25.02
18,500 to 19,000									13.22
19,000 to 19,500									1.51
19,500 to 20,000									
20,000 to 20,500									11.05

FROM OCTOBER TO MARCH.

Height (in meters).	Ci.		Ci-S.		Ci-Cu.		A-S.		A-Cu.	
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.
500 to 1,000										
1,000 to 1,500										
1,500 to 2,000										
2,000 to 2,500										
2,500 to 3,000										
3,000 to 3,500					5.84	1			3.99	7
3,500 to 4,000	5.91	1			4.26	3	18.97	1	2.81	8
4,000 to 4,500	5.91	1			1.10	1			2.03	2
4,500 to 5,000	26.88	1			1.96	2			3.91	6
5,000 to 5,500					2.82	4			2.41	3
5,500 to 6,000	4.50	5			2.50	3			7.38	3
6,000 to 6,500	12.62	2			3.69	5			2.70	2
6,500 to 7,000	7.97	4	3.51	2	1.66	1			9.54	1
7,000 to 7,500	11.54	3			9.24	2			9.54	2
7,500 to 8,000	10.36	3	8.59	2	3.57	1			9.51	1
8,000 to 8,500	33.56	3	6.15	1						
8,500 to 9,000	15.19	3	10.79	1	0.50	2				
9,000 to 9,500	17.15	5	18.84	4						
9,500 to 10,000	9.67	3	17.84	3						
10,000 to 10,500	11.95	3	15.53	4						
10,500 to 11,000	10.54	6	8.90	1						
11,000 to 11,500	16.21	11								
11,500 to 12,000	12.29	4								
12,000 to 12,500	10.30	6	8.04	4						
12,500 to 13,000	17.42	4	9.84	3						
13,000 to 13,500	13.01	2	8.70	1						
13,500 to 14,000	13.86	1	9.13	2						
14,000 to 14,500	12.86	4								
14,500 to 15,000			84.71	1						
15,000 to 15,500	5.54	4	29.68	4						
15,500 to 16,000	11.81	8								
16,000 to 16,500										
16,500 to 17,000										
17,000 to 17,500	2.97	2								
17,500 to 18,000	17.36	1								
18,000 to 18,500										
18,500 to 19,000										
19,000 to 19,500										
19,500 to 20,000										
20,000 to 20,500										

TABLE CIV B.—*Mean velocity and frequency at different altitudes*—Continued.

FROM OCTOBER TO MARCH—Continued.

Height (in meters).	S-Cu.		N.		Cu.		Cu-N.		Mean velocity, m. p. s.
	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	Velocity, m. p. s.	Number of cases.	
500 to 1,000			2.25	2	6.42	7			5.49
1,000 to 1,500	1.57	2	5.49	7	5.28	54	2.70	3	5.07
1,500 to 2,000	9.23	4	7.93	10	6.83	86	2.90	7	6.67
2,000 to 2,500	10.17	2	4.01	4	7.39	44	9.77	5	7.49
2,500 to 3,000					8.96	21	12.24	9	9.96
3,000 to 3,500					7.40	5	8.89	1	5.69
3,500 to 4,000					14.54	2	2.36	2	5.53
4,000 to 4,500							8.24	6	6.05
4,500 to 5,000							8.89	1	6.32
5,000 to 5,500									2.66
5,500 to 6,000							3.96	2	4.62
6,000 to 6,500							1.98	1	5.11
6,500 to 7,000									6.26
7,000 to 7,500							2.98	2	8.68
7,500 to 8,000							13.25	2	9.76
8,000 to 8,500									26.71
8,500 to 9,000									9.56
9,000 to 9,500									17.90
9,500 to 10,000									13.71
10,000 to 10,500							10.29	2	13.16
10,500 to 11,000									10.37
11,000 to 11,500									16.21
11,500 to 12,000									12.29
12,000 to 12,500									9.40
12,500 to 13,000									14.17
13,000 to 13,500									11.51
13,500 to 14,000									10.77
14,000 to 14,500									12.86
14,500 to 15,000									84.71
15,000 to 15,500									17.61
15,500 to 16,000									11.81
16,000 to 16,500									
16,500 to 17,000									
17,000 to 17,500									2.97
17,500 to 18,000									17.36
18,000 to 18,500									
18,500 to 19,000									
19,000 to 19,500									
19,500 to 20,000									
20,000 to 20,500									

TABLE CV A.—*Frequency of winds at different altitudes.*

GROUP I.

Direction.	0-1,000	1,000-3,000	3,000-5,000	5,000-7,000	7,000-10,000	10,000-13,000	13,000-16,000	16,000-19,000	19,000-22,000
N	......	18	......	......	......	......	......	......	......
NNE	......	28	4	1	3	2	......	......	......
NE	......	20	2	......	......	......	......	......	......
ENE	......	45	6	7	......	......	1	2	......
E	......	41	7	......	......	2	1	2	......
ESE	......	20	1	......	1	2	......	......	......
SE	2	11	2	......	7	4	......	1	......
SSE	......	1	......	......	3	4	3	......	......
S	......	2	2	2	5	2	1	......	......
SSW	......	......	......	2	1	1	2	......	......
SW	......	4	2	2	2	7	......	......	......
WSW	......	2	1	1	3	5	1	1	......
W	......	......	......	6	1	2	......	......	......
WNW	......	......	3	......	......	......	1	1	......
NW	......	3	......	......	......	3	2	......	......
NNW	......	......	......	......	......	......	......	......	......
Mean direction	S. 45° 0′ E.	N. 67° 52′ E.	N. 83° 50′ E.	S. 17° 49′ E.	S. 10° 39′ E.	S. 21° 16′ W.	S. 36° 51′ W.	N. 88° 16′ E.	......

GROUP II.

N	......	1	......	5	8	4	......	......	......
NNE	......	13	3	1	7	8	......	......	......
NE	......	21	1	3	9	6	......	......	......
ENE	......	23	5	10	8	11	6	......	......
E	2	15	6	2	5	6	......	......	......
ESE	1	21	5	......	2	2	7	......	......
SE	1	13	3	1	5	......	......	......	......
SSE	......	3	2	......	......	......	......	......	......
S	......	2	5	2	1	2	......	......	......
SSW	......	7	1	5	......	......	2	......	......
SW	2	1	1	1	3	8	......	......	......
WSW	......	1	......	......	......	......	......	......	......
W	1	6	5	2	2	2	2	......	......
WNW	......	......	......	......	1	3	......	......	......
NW	......	1	......	......	2	......	......	......	......
NNW	1	1	2	2	......	5	......	1	......
Mean direction	S. 27° 49′ E.	N. 83° 18′ E.	S. 68° 06′ E.	N. 62° 19′ E.	N. 40° 40′ E.	N. 37° 02′ E.	S. 76° 26′ E.	N. 22° 29′ W.	......

TABLE CV A.—*Frequency of winds at different altitudes*—Continued.

GROUP III.

Direction.	0-1,000	1,000-3,000	3,000-5,000	5,000-7,000	7,000-10,000	10,000-13,000	13,000-16,000	16,000-19,000	19,000-22,000
N				3	1	2		1	
NNE				4	7	13	7	1	
NE		1	2		14	9			
ENE	3	4	5	8	19	8	2	2	
E	2	6	3	5	12	15	5		
ESE	2	8	2	3	4	3			
SE	1	12	4	3	8	7	1		
SSE	3	1	3						
S						3			
SSW		10							
SW	2	5	2	3	4	4	1		1
WSW	5	9	10	6	2	4	2		
W	2	8	4	1	3		1		2
WNW		4		3		2			
NW			2	2			1		
NNW		1	1						
Mean direction	S. 3° 55′ E.	S. 15° 17′ E.	S. 69° 53′ W.	N. 52° 10′ E.	N. 72° 27′ E.	N. 72° 00′ E.	N. 46° 02′ S.	N. 31° 45′ E.	S. 75° 22′ W.

TABLE CV B.—*Frequency of the winds at different altitudes.*

FROM APRIL TO SEPTEMBER.

Direction.	0-1,000	1,000-3,000	3,000-5,000	5,000-7,000	7,000-10,000	10,000-13,000	13,000-16,000	16,000-19,000	19,000-22,000
N				3	3	6		1	
NNE				4	10	19	7	4	
NE		5	2	1	20	14			
ENE	3	23	7	16	27	14	2	2	
E	2	18	8	5	15	21	5		
ESE	2	21	2	3	6	3	2		
SE	1	20	4	3	13	7	1		
SSE	3	1	3						
S		2	2		3	5			
SSW		10		3			2		
SW	2	6	2	7	4	12	1		1
WSW	5	9	10	6	2	4	2		
W	3	13	9	3	5	2	3		2

WNW		4		3	4	5			
NW			2	2		3	1		
NNW		1	1						
Mean direction	S. 1° 58′ W.	S. 57° 48′ E.	S. 2° 2′ E.	N. 70° 50′ E.	N. 71° 13′ E.	N. 60° 10′ E.	S. 58° 5′ E.	N. 31° 45′ E.	S. 75° 22′ W.

FROM OCTOBER TO MARCH.

N		19		5	6				
NNE		41	7	2	7	1			
NE		37	3	2	3	1			
ENE		49	9	9		5	7	2	
E	2	44	8	2	2	2	1	2	
ESE	1	28	6		1	4	5		
SE	3	16	5	1	7	4		1	
SSE		7	2		3	4	3		
S		2	5	4	6	2	1		
SSW		7	1	4	1	4	2		
SW	2	4	3	2	5	7			
WSW		3	1	1	3	5	4	1	
W		1		6	1	2			
WNW			3				1	1	
NW		4			2	3	2		
NNW	1	1	2	2		2		1	
Mean direction	S. 66° 06′ E.	N. 67° 19′ E.	S. 87° 26′ E.	N. 61° 27′ E.	S. 42° 09′ E.	S. 15° 21′ E.	S. 68° 06′ E.	N. 67° 06′ E.	

CHAPTER VIII.

BAGUIOS OR CYCLONES OF THE EXTREME EAST.

I.—DEPRESSIONS OR EXTENDED AREAS OF LOW PRESSURE.

TWO CLASSES OF ATMOSPHERIC CHANGES IN THE PHILIPPINES.

Two classes of atmospheric changes may be distinguished in the Philippine Archipelago and the seas which surround it, due to more or less developed centers of low pressure. One we simply indicate under the general name of depressions, and the other we call baguios or Philippine cyclones, the latter, as is known, not falling short of the cyclones of the Indian Ocean nor of the hurricanes of the Atlantic.

Although it is our intention to speak in this chapter somewhat at length concerning the latter, both because of their frequency in this archipelago and because of their terrible effect on war vessels and merchant vessels which navigate these seas, we do not believe it inappropriate to first say, by way of preamble, a few words concerning the first class of atmospheric changes which we have just indicated.

DIVISION OF DEPRESSIONS INTO TWO GROUPS.

For greater clearness we consider these depressions divided into two groups; one of them originating in low latitudes between 4° and 12° north latitude, and the other formed in a higher latitude, probably between 16° and 22°.

DEPRESSIONS IN LOW LATITUDES.

The first, as we have had occasion to say many times in meteorological articles in our monthly bulletins, are nothing more than extended areas of low pressure which extend in a fairly uniform manner over immense regions, and occur principally in the months of December, January, February, and March. In the majority of cases it is very difficult to distinguish in these depressions a true movement of transference, as also to accurately locate the center before the beginning of the barometric descent or the lowest barometric pressure, which is often observed at the same time in all the archipelago, and probably even in part of the Pacific and the China Sea. This minimum reading of the barometer is generally in the Visayan Islands and Mindanao—that is, in the southern region of the Philippines—and is 2 or 3 mm. lower than normal.

EFFECT OF THESE DEPRESSIONS.

The immediate effect of this kind of atmospheric disturbances is manifested by brisk winds from the first quadrant and rains of greater or less abundance in the Visayan Islands and Mindanao, which frequently extend as far as the provinces of the south of Luzon. Whenever it has been possible to locate the center of any one of these depressions between Visayas and Mindanao, it has generally been observed that in the southern part of the region moderate or brisk winds from S. to SW. prevail.

SOMETIMES THESE DEPRESSIONS ARE CONVERTED INTO GENUINE CYCLONE CENTERS IN THE SEA OF CHINA.

Although the data at our disposition is at present very scanty, it would appear that some of these wide centers of low pressure, after having crossed the southern part of the archipelago as depressions such as we have just described, by a movement of transference, better defined in some cases than in others, acquire, perhaps, a greater development in the China Sea, being converted into genuine cyclone centers.

DEPRESSIONS FORMED IN HIGHER LATITUDES.

The other depressions which, as already indicated, usually form in higher latitudes, are also wide areas of low pressure prolonged from east to west, or from ENE. to WSW., and which usually remain for some days either to the northwest of Manila, between the northwest of Luzon and the south of China, or in the Pacific, toward the northeast or NNE. of Manila; or perhaps they also extend themselves along some part of the China Sea and the Pacific, between the north of Luzon, the south of China, Formosa, and the Liukin Islands. These depressions occur in the months in which baguios are most frequent, especially in June and July.

EFFECT OF THESE DEPRESSIONS.

Toward the north of these wide centers of low pressure brisk winds from north to east prevail, and also to the south of these brisk winds from S. to SW. In Manila winds neither brisk nor light prevail from SSE. and S. when the depression lies to the NW. in the China Sea, and winds between brisk and strong prevail from S. to SW., when it is situated more to the north or to the NNE. and NE. in the Pacific.

COLLAS.

In the latter case these winds from the third quadrant, together with the squalls which accompany them at intervals for several days constitute the phenomenon known to the natives by the name of colla.[1] These depressions sometimes give place to the formation of genuine cyclone centers.

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[1] This same phenomenon is at times produced by two typhoons when they move with great slowness in the Pacific to the NE. or NNE. of Manila, or when they follow one another almost without interruption in the Pacific itself.

PRINCIPAL OBJECT OF THE PRESENT CHAPTER AND DATA WHICH HAS BEEN USEFUL TO US IN THE STUDY OF THE BAGUIOS OR CYCLONES OF THE EXTREME EAST.

Having given these general ideas concerning depressions of minor importance we pass on to discuss, as briefly and clearly as possible, part of much that might be said concerning true and typical cyclones, possessing the two movements of rotation and transference, which are known in the Philippines under the name of baguios, and under the name of typhoons in the China Sea. Much of what we shall say is founded on what was written in 1897 by P. José Algué in his valuable work, "The Baguios or Philippine Cyclones," and also on other data collected in this observatory, especially in regard to the baguios of 1895, 1896, 1897, and 1898. In making up the statistics of baguios for certain years we have availed ourselves of the publications of the meteorological observatories of Tokio, Zikawei, and Hongkong.

II.—MONTHLY DISTRIBUTION OF BAGUIOS, 1880–1898.

NUMBER OF BAGUIOS OBSERVED IN THE PERIOD OF 1880 TO 1898 AND THEIR DISTRIBUTION THROUGHOUT THE DIFFERENT MONTHS OF THE YEAR.

In the first place, we believe it will be of especial interest and practical value to know something of the distribution of baguios over the different months of the year, so as to find in what month they appear with greatest frequency and what months are free from them. For this purpose we have included those baguios which have appeared in this archipelago, either crossing it, or passing through it for a greater or less distance, and whose trajectory this observatory has been able to discover.[1] There are 397 of these baguios, whose distribution, by month and year, can be seen from the following table:

TABLE CVI.—*Monthly and yearly distribution of Baguios, 1880–1898.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1880	......	......	......	......	......	......	2	4	2	2	1	......	11
1881	......	......	......	......	2	1	3	4	4	3	3	1	21
1882	......	......	......	1	......	......	3	......	2	2	1	2	11
1883	......	......	1	1	3	1	3	4	4	4	1	......	22
1884	1	......	......	......	2	1	4	5	4	......	2	2	21
1885	......	......	......	1	......	2	2	2	1	1	1	1	11
1886	......	......	......	1	1	2	......	3	4	3	1	1	16
1887	......	......	1	3	3	1	5	2	7	3	3	......	28
1888	......	......	......	1	......	2	4	3	3	1	1	1	16
1889	......	......	......	......	......	......	2	3	2	4	1	2	14
1890	1	......	......	......	1	5	4	2	7	6	1	......	27
1891	......	......	......	1	2	2	7	5	6	......	4	1	28
1892	1	......	......	......	......	3	4	4	5	2	3	2	24
1893	2	......	......	......	2	1	3	4	6	3	2	1	24
1894	......	......	......	......	4	3	5	3	5	5	6	3	34
1895	1	......	......	......	1	4	2	3	5	3	5	......	24
1896	......	......	......	......	1	2	4	4	5	4	......	......	20
1897	......	......	......	......	......	2	6	2	3	5	2	......	20
1898	......	......	1	......	2	3	3	6	4	3	2	1	25
Total	6	0	3	9	24	35	66	63	79	54	40	18	397
Averages	0.3	0.0	0.2	0.5	1.3	1.8	3.5	3.3	4.2	2.8	2.1	0.9	20.9
Per cent	2	0	1	2	6	9	17	16	20	14	10	5	

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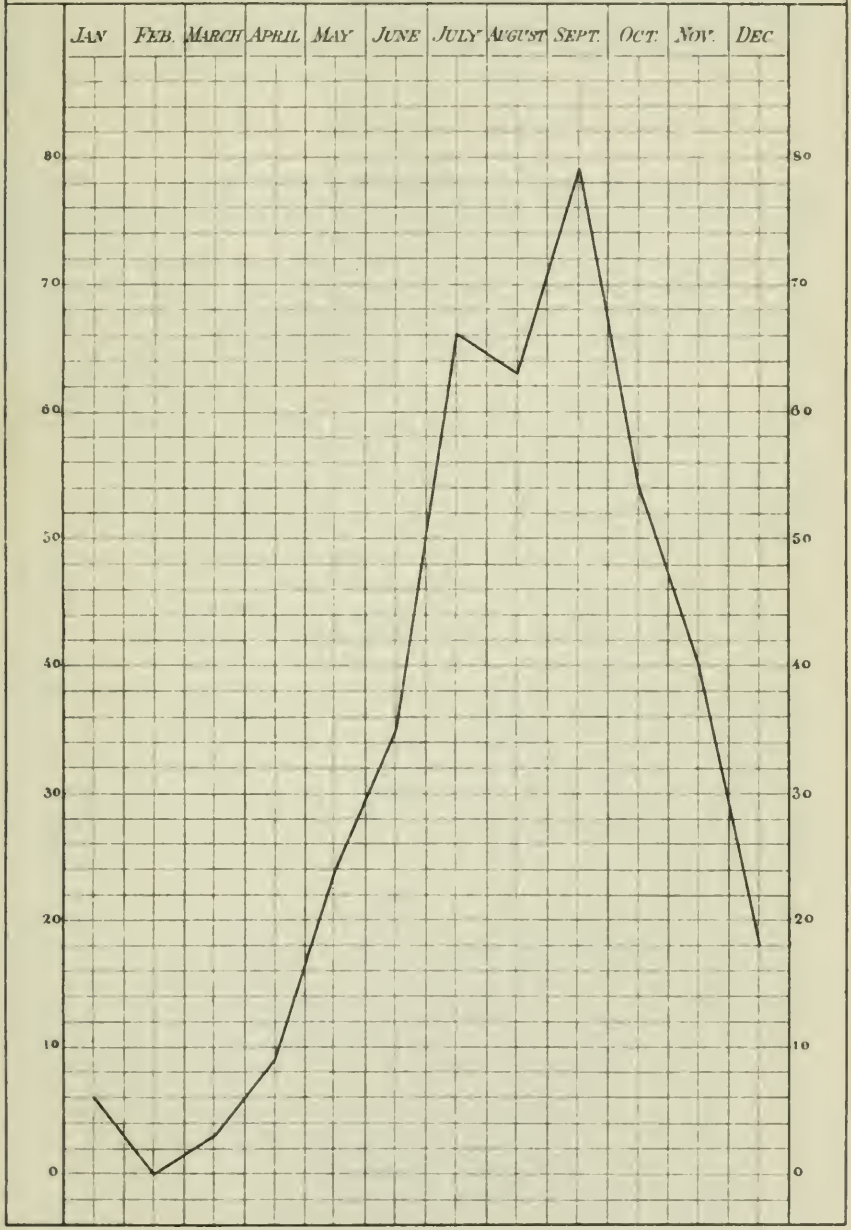
[1] We begin with the year 1880, as this was the first year in which our observatory sent notices of typhoons to the neighboring colony of Hongkong, as telegraphic communication was then established.

PLATE XLI.

MONTHLY DISTRIBUTION OF THE BAGUIOS OR CYCLONES IN THE FAR EAST

1880-1898



[illegible]

As will be seen, not one of these 397 baguios which have been registered from 1880 to 1898 has been observed in the month of February, and only 3 in the month of March. Their frequency then increases from April, when 9 occurred, to July, when 66 occurred. There is then a slight decrease for the month of August, and the maximum of 79 is reached in September, thus giving a yearly average of 4 for this month. From October the number gradually diminishes up to January, when but 6 are recorded.

ANNUAL MEAN FOR THE PERIOD 1880 TO 1898.

Taking the average of the total number of baguios observed during the nineteen years included in the previous table, we find a general yearly average of 19. This average would be greater if we should include only the last two years, as, on account of more available data and better methods of observations, it has been more difficult for any typhoon to occur in these seas without being recorded. This was not true of the first few years, because methods of securing information were much more defective.

In confirmation of this it is sufficient to say that since the year 1892, when this observatory began to receive monthly reports of daily observations taken on the island of Guam (Marianas Islands), we have been able to record various cyclones, as, for example, three for the month of February, 1895,[1] and one for the month of April, 1899,[2] which passed near that island on the south and west in the Pacific without coming near the Philippines, and concerning which we would have had no information if it had not been for these reports.

Again, in the same meteorological review of the monthly bulletin of this observatory for the years 1880, 1881, and 1882 we find various phenomena described for which we could not then give a satisfactory explanation, but which we now know take place whenever a cyclone occurs at some distance from the archipelago, especially in the vast extent of the Pacific Ocean east and northeast of Luzon. Such are, for example, the winds from the southwest, which blow during certain days in the months of April and May, and which are accompanied with frequent showers and squalls. This happened among other cases which we might cite during the last ten days of April, 1880, and May, 1882, during which months no baguio was recorded, not because none might not have occurred, but because at that time we did not have the same facilities as at present for studying and tracing their paths.

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[1] We give a brief account of these baguios in the meteorological review in our monthly bulletin for November, 1895. The last of these, which occurred in Marianas the 20th, touched the southern part of the port of San Luis de Apra, where the barometer fell 22 mm. in two hours and ten minutes, the lowest reading being 730 mm. The wind blew a hurricane from NNW. and N. to NE. and SE., causing great damage in the town. The change from NE. to SE. was observed about half an hour.

[2] This baguio was felt in Guam the 25th and 26th. For the observations concerning it we are indebted to the generosity of Mr. Stovell, captain of the steamer *Nanshan*, which was anchored there at that time. According to these the barometer reached its lowest reading of 741 mm. at 4 p. m. of the 25th, and the winds, having a velocity of 8, 9, and 10, according to Beaufort's scale, were successively from E. to SE., S., and SW., and were accompanied by strong squalls. This tempest moved around the west of Guam without touching the Philippine Archipelago. The movement of this baguio about the island of Guam is indicated not only by what we have just said concerning the change of winds, but also by the maintenance of the barometric pressure during all the 26th at about the same height that it was the afternoon of the 25th. Nevertheless, the observations of the 26th and 27th would seem to indicate that it again turned to the N. or NNW., from which point i was not possible to follow its farther course in the Pacific.

ANNUAL MEAN FOR THE LAST NINE YEARS.

In view of this, taking the baguios registered during the last nine years separately—that is to say, from the period 1890 to 1898—we find an average of 25 baguios for each year, as the average of the 226 that were registered during these nine years is 25.11.

III.—MINIMUM DISTANCE OF BAGUIOS FROM MANILA.

DIVISION OF THE BAGUIOS OBSERVED DURING THE PERIOD 1890 TO 1898 INTO FOUR GROUPS, ACCORDING TO THEIR MINIMUM DISTANCE FROM MANILA.

Taking as a foundation the 397 baguios registered during the nineteen years from 1880 to 1898, we shall consider in this paragraph their relative distance with respect to Manila. This, we believe, will be both of interest and utility. For this purpose we have divided these baguios into four groups, according to their minimum distance from the capital of the archipelago, as follows: First group, less than 10 miles; second, from 10 to 60 miles; third, from 60 to 120 miles; fourth, more than 120 miles.

Thus grouped, these baguios are distributed throughout the various months of the year as seen in the following table:

Table CVII.—*Minimum distance with respect to Manila of the 397 baguios observed in the period 1880 to 1898.*

Distance (minimum).	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
0 to 10 miles	......	......	......	......	1	......	......	......	1	1	3	......	6
10 to 60 miles	......	......	......	......	6	1	2	2	7	6	3	1	28
60 to 120 miles	......	......	1	1	2	3	4	4	5	9	3	4	36
120 miles	5	......	2	8	15	31	60	57	66	39	31	13	327

MONTHS IN WHICH OCCUR THOSE BAGUIOS MOST TERRIBLE AND DANGEROUS FOR MANILA.

From this data it is evident that the months when the baguios most dangerous to Manila are felt are May, September, October, and November, for in these months there have been registered the 6 baguios which, during the period 1880 to 1898, crossed the island of Luzon and passed within 10 miles of the capital. Besides the 28 baguios which passed within a distance of from 10 to 60 miles of Manila, 22 occurred luring the four months mentioned. In July and August, even though the baguios are inclined toward the west, they usually pass along the higher latitudes, and are more dangerous to the north of Luzon, Formosa, and the coast of China lying between Hongkong and Shanghai. Nevertheless, as rare cases, we should mention certain baguios which cross the archipelago through the Visayan Islands, or south of Luzon, even in these months. Such was the baguio which, on the 1st and 2d of August, 1896, crossed the southern part of the island of Luzon, and whose course is given in paragraph 6 of this chapter (Plate XLVIII); also, that on the 3d and 4th of August, 1897, which crossed the islands of Luzon and Panay.[1]

VI.—BAGUIOS WHICH HAVE PASSED TO THE NORTH, SOUTH, EAST, AND WEST OF MANILA.

DIVISION OF BAGUIOS INTO FIVE MAIN GROUPS, ACCORDING TO THE POSITION OF THEIR PATHS WITH RESPECT TO MANILA.

In this paragraph we shall consider baguios divided into five main groups, each one having typical and special characteristics quite worthy of being studied: Baguios which have crossed north of Manila; baguios which have crossed south of Manila; baguios which have passed east or northeast of the archipelago in the Pacific, but which have disappeared before reaching these islands (which rarely occurs), or which have recurved before crossing the meridian 121° east of Greenwich, which is approximately the meridian of Manila; baguios formed in the China Sea to the west of the Philippines; and baguios which recurve in the China Sea between the parallels of 10° and 20°, passing first to the south and afterwards to the north of Manila. The characteristics of the baguios corresponding to each one of these groups are as follows:

CHARACTER OF THOSE BAGUIOS WHICH CROSS TO THE NORTH OF MANILA.

These are the baguios most dangerous to Manila, if they cross the island of Luzon not far from the capital. The winds blow from N. to NW. and from W. to SW., so that the vortex approaches our meridian with gradually increasing intensity; in general, the most violent winds are those from WSW. and SW. After the baguio has crossed to the north in the direction of the China Sea the force of the wind gradually decreases, but continues to blow from the SSW. and S., and even from the SE., in those cases where the storm is sufficiently inclined to the west. If the distance of the vortex from Manila is not less than 60 miles, the winds will scarcely reach a greater force than 9 or 10 of the Beaufort scale. If the distance is less than 180 miles the influence of the cyclone usually lasts in Manila not more than two days. If it is situated in the high altitudes, such as in the vicinity of the Baschi and Balingtang channels or near the island of Formosa, then, even though the baguio is to the northeast in the Pacific, strong winds from WSW. and SW. quickly appear; these being accompanied by squalls. This bad weather continues for three or four consecutive days.

CHARACTER OF THOSE BAGUIOS WHICH CROSS TO THE SOUTH OF MANILA.

It is worthy of notice, and all who have lived in Manila for some years have undoubtedly noticed it, that a striking difference is observed when a comparison is made of the influence exerted on Manila by a baguio crossing to the north and that exerted by one crossing to the south, although the minimum distance of both may be the same. The first are felt with much greater intensity than the second; not alone when the distances are equal, but also when the distances of the latter are much less. Thus, speaking in general, it may be said: First, that a baguio which crosses south of the meridian of Manila, at a distance of from 10 to 60 miles, exercises the same influence on the capital and perhaps even less than another which crosses to the north at a distance of from 60 to 400 miles; second, that those which cross to the south at a distance of from 60 to 150 miles have much less influence than those which cross to the north at a distance of from 400 to 700 miles. So great is this influence that for baguios which are more than 400 miles distant, like that of the 6th to the 9th of August, 1897,[1] which crossed the meridian of Manila north of Formosa, it has been necessary in this port to show the second tempest signal; while for those which crossed to the south not more than 120 miles away the winds of the second quadrant rarely, if ever, acquired sufficient force to cause the observatory to display any signal whatever. The causes of these facts we believe to be two: First, that the typhoons which move from west or WNW. along parallels lower than 15° are generally of great intensity if in the vicinity of the vortex, which is very much reduced in diameter. Those which run farther to the north are in general of much larger dimensions, increasing in size with the latitude where they occur. And, second, that the winds from the NE. and SE., which blow in Manila when a baguio passes through the south, are opposed by great mountain ranges; while those from the WSW. and the SW. strike the Bay of Manila without encountering any obstacle.

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[1] The first of these baguios is described at length in the work which has just been published, entitled "Typhoons of the Philippine archipelago and surrounding seas, 1895 and 1896," by P. Juan Doyle, subdirector of the observatory. We describe the second briefly in the meteorological review of our monthly bulletin for August, 1897.

CHARACTER OF THOSE BAGUIOS WHICH RECURVE INTO THE PACIFIC WITHOUT CROSSING THE MERIDIAN OF MANILA.

The effect of these baguios in Manila is similar to that produced by those which cross to the north some distance away, with the single difference that the strong wind and wind and rain squalls from the third quadrant continue at times for five or six days.

The intensity of these rains is naturally so much the greater as the distance which separates the vortex from the island of Luzon decreases. If this distance is more than 700 miles its influence is scarcely felt in Manila, except for the greater constancy of those winds which blow from the WSW. and SW. These blow even outside of the regular hours for breezes, as happened in the baguio of the 6th to 9th of September, 1897, and that which damaged Kobe the 15th of August of this year.

CHARACTER OF THOSE BAGUIOS WHICH FORM IN THE CHINA SEA TO THE WEST OF THE ARCHIPELAGO.

These baguios are those which are felt least in Manila. As a general rule they follow from the point of their formation toward the fourth quadrant, and most commonly toward the NW. or WNW. For this reason they are soon far from the archipelago, and so influence Manila only by means of their showers and mild or brisk breezes from the S. to the SE.

Although not frequent, baguios are occasionally registered which, forming in the China Sea, move to the N. and NE., passing thus to the north of Manila. When this happens their influence is prolonged for some days, the winds veering from SE. to S. and SW. as the vortex advances toward the NE.

CHARACTER OF THOSE BAGUIOS WHICH RECURVE IN THE CHINA SEA BETWEEN THE PARALLELS 10° AND 20°, PASSING FIRST TO THE SOUTH AND AFTERWARDS TO THE NORTH OF MANILA.

The influence of these baguios, especially if they do not go far in the China Sea before recurving, is usually prolonged for six or eight or more days, being accompanied at first with quite continuous rains and brisk winds, which veer from N. to NE., E. and ESE., while the vortex crosses to the south and passes into the China Sea. During this recurve the velocity of the storm usually diminishes notably, rains and brisk breezes continuing at Manila. These breezes from the ESE. veer to the SE. and SSE. very slowly. When, at the end of three, four, or five days, the baguio has completed this recurve, it quickly continues its course to the NNE., NE., or ENE. This change of position of the vortex, if the baguio is not too distant from Manila, is accompanied here by a rapid veering of the winds from the SSE. to the SSW., SW., WSW., and W., these increasing in force until the baguio has a second time crossed the meridian of Manila to the north. To this class belonged the "Gravina" baguio (so called because of the wreck of this merchant vessel near the coast of Zambales) of the 8th to the 14th of May, 1895, and the baguio of Iloilo and Vigan of the 9th to 17th of May, 1896. The vortex of this baguio passed Iloilo during the first part of its parabolic path and touched Vigan, when, after recurving, it crossed the NW. extremity of Luzon, moving to the NE. The paths of these two baguios and others similar to them can be seen in paragraph 6 of this chapter, Plate L.

Knowing thus in general the influence which a baguio may have on Manila, according as it belongs to one or the other of these five groups, it is easy to see that it will be useful to know the months in which the baguios of these different groups occur. For this purpose we have prepared the following table:

TABLE CVIII.—*Monthly distribution of baguios for the period 1880 to 1898, according to the position of their paths with respect to Manila.*

	Jan.	Feb	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Per cent.
North of Manila	......	......	......	......	3	5	32	26	29	20	6	......	121	30
South of Manila	4	......	......	5	9	5	7	6	6	13	19	11	85	21
East of meridian 121°	2	......	2	3	6	12	14	21	33	11	11	6	121	31
West of archipelago	......	......	......	1	2	12	13	7	11	10	2	......	58	15
First south then north of Manila	......	......	1	......	4	1	......	......	......	......	2	1	9	2

RELATIVE FREQUENCY OF BAGUIOS OF EACH ONE OF THESE FIVE GROUPS.

According to this data those baguios which cross the north of Manila and those which remain in the Pacific east of the meridian 121° east of Greenwich, are most frequent. Those which cross south of Manila are less frequent, while those formed west of the meridian 121° east of Greenwich are still less frequent. Those baguios which recurve in the China Sea between the parallels 10° and 20°, crossing first to the south and then to the north of Manila, occur, as will be seen in the table, but rarely.

MONTHLY DISTRIBUTION.

In regard to the monthly distribution of the baguios of these five groups it is evident, first, that those which cross to the north of Manila are more frequent in the months of September, July, August, and October, though they occur sometimes in the months of November, May, and June, but never during the rest of the year; second, that those which cross to the south are most common in November, October, May, and December, and are rarely seen in April, June, July, August, September, and January; third, that those which recurve into the Pacific to the east of meridian 121° east of Greenwich are very frequent in September, quite frequent in August and July, less so in June, October, and November, and rare in the other months; fourth, that those formed in the China Sea to the west of meridian 121° east from Greenwich are fairly frequent from June to October, inclusive, in descending grade through June, July, and August, and ascending from August to October, the maximum being in the months of June and July, this being the so-called typhoon epoch. Very few have observed them in May, November, and April, and none in the other months; fifth, that of the last group of baguios but nine have been registered in the period under discussion—one in March, one in June, one in December, two in November, and four in May—they being peculiar therefore to this last month. Thus, in the year 1899 we observed a baguio of this group from the 18th to the 28th of May which first crossed the Visayan Islands, being severely felt in Iloilo and Cebu on the 20th and 21st. It then recurved into the China Sea to the south of Hongkong, between the parallels 17° and 20°, and was lost in the Pacific Ocean to the north of Formosa. Its path may be seen in paragraph 6, Plate L.

V.—ZONES WHERE BAGUIOS ORIGINATE.

REGIONS WHERE PHILIPPINE CYCLONES USUALLY ORIGINATE.

Following the empirical method, we shall indicate here, with as great clearness and precision as possible, regions where Philippine cyclones usually originate. But we will first cite what Father Benito Viñes, referring to tropical cyclones in general,[1] and Father Estanislao Chevalier, speaking of the typhoons of the extreme Orient in particular, say concerning the zones of cyclone formation.

"It must be admitted," said Father Viñes, "that tropical cyclones do not originate in any accidental point of the intertropical zone, but elect by preference a special and determined region in said zone for their formation and development. The intertropical cyclonic regions in general unite, in a more or less perfect degree, the following geographical conditions: Great continents to the west, broken by numerous gulfs and bays, whose coasts extend in the general direction north to south, with vast and extensive seas to the east, dotted most commonly with numerous islands. Such are at least the characteristics which, in more or less perfect degree, are found united in the cyclonic regions of the Philippines, those of the China Sea, those of the Indian Ocean, those of the Australian region, and those of the region situated east of Africa in the vicinity of the islands of Madagascar, Mauricio, Reunion, Rodriguez, etc."

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[1] Investigations concerning cyclonic circulation and transference in the hurricanes of the Antilles, part 2, law 4, paragraph 4.

Father Chevalier says:

> Some typhoons originate in the China Sea, but they are very few. Usually they originate to the east of the Philippines, within an area vaguely bounded by the meridians 125° and 145° E. of Greenwich, and the parallels 10° and 25° N. latitude. We are not certain that they are formed farther to the east, although we hold it probable. In any event, if they do form to the east of the meridian indicated, they do not advance sufficiently to the west to reach the coast of China or of Japan.

Concerning these opinions we shall only refer to what Father Algué says on page 17 of his work on Baguios or Philippine Cyclones, that many baguios are formed in lower latitudes than 10° north, and that, on the other hand, very few, if any, originate above the twentieth parallel to the ENE. of the N. of Luzon. Therefore, speaking in general, we may indicate the limits of the zone of cyclone formation in the Pacific, and also that of the China Sea, as the fifth and twentieth parallels of north latitude. In regard to the limits of longitude, they would seem to us to be very closely approximated, if we consider only those typhoons which influence the Philippines or Japan. According to observations taken in San Luis de Apra (Guam, Marianas, latitude 13° 27′ 51″ N., longitude 144° 44′ E. from Greenwich), six baguios during the years 1895 and 1896 were felt in that port, one crossing to the north and the other to the south. These evidently came from the east; that is, from meridians east of 145°, but of them one only reached the Philippines, the others remaining in the Pacific without approaching either the Philippines or Japan. Therefore, including these baguios of the Marianas Islands, as we have already considered them in this paper, we may indicate as the limits of longitude of all baguios formed in the Pacific the meridians 125° and 150° E. of Greenwich.[1]

Considering separately those baguios originating in the Pacific and those originating in the China Sea, and paying special attention to the different months of the year, we shall attempt to locate the zone of formation corresponding for each one of these.

PROBABLE LIMITS OF THE ZONE OF FORMATION OF BAGUIOS ORIGINATING IN THE CHINA SEA.

The number of these baguios is relatively insignificant if it is compared with the number of those originating in the Pacific. Briefly, the zone of their formation is limited by the fifth and twentieth parallels of latitude and the one hundred and twelfth and one hundred and twentieth meridians east from Greenwich. It should, however, be noted that very few originate between the fifth and fourteenth parallels[1] and that a majority of them originate between the fourteenth and twentieth parallels to the W. or NW. of Luzon, and almost always at a distance of more than 120 miles from Manila.

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[1] In Plate XLII we shall give farther down in paragraph 6 the path of a baguio occurring from the 28th of December, 1892, to the 2d of January, 1893, which originated between the meridians 151° and 152° E. from Greenwich, according to observations taken on board the steamship *Venus* on its voyage from Ponape (Caroline Islands) to Marianas.

PROBABLE LIMITS OF THE ZONE OF FORMATION OF BAGUIOS ORIGINATING IN THE PACIFIC, DECEMBER TO MARCH; APRIL, MAY, OCTOBER, AND NOVEMBER; JUNE TO SEPTEMBER.

Baguios which originate farther to the east of the Marianas, and which are therefore dangerous to those islands, in our opinion occur principally in the months of October, November, December, January, and April, especially during the first two. Outside of this class of baguios, which, as we have already said, remain in the Pacific and are scarcely felt in our archipelago, the zone of formation of the other baguios of the Pacific is outlined by Father Algue as follows:[2]

> For greater clearness we may determine the probable corresponding zones of each one of the three groups of months into which we may consider the year divided.[3]
>
> *December–March.*—The greater part of the baguios which are developed during these months originate in latitudes lower than 10°, although during the early part of December and the latter part of March some baguios originate above the tenth parallel. Speaking in general of this group, we may place the zone of origin between the fifth and twelfth parallels of latitude and the one hundred and fortieth and one hundred and fifty-first meridians east of San Fernando (one hundred and thirty-fourth to one hundred and forty-fifth east of Greenwich).
>
> *April, May, October, and November.*—It is necessary to note that in these three groups the first and last months possess some common characteristics; thus, for example, baguios observed during the early part of October have the same characteristics as those observed in September, even though these months belong to distinct groups. In the same way the baguios of the end of November are similar to those of December, and those of the end of May have at times some characteristics similar to those of June.
>
> The zone formation of the baguios developed during the months of this second group is somewhat more extended than the previous one. Speaking in general, it lies between the sixth and seventeenth parallels and the one hundred and thirty-fifth and one hundred and forty-eighth meridians east of San Fernando (one hundred and twenty-ninth to one hundred and forty-second east of Greenwich).

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[1] In the publications of the observatory of Hongkong we frequently find the paths of typhoons indicated, whose apparent origin was the China Sea, NW. or N. of Paragua, between the tenth and fourteenth parallels of latitude; but if the announcements of typhoons made by our observatory are considered, it will easily be seen that many of these baguios do not originate in the China Sea, but come from the Pacific and cross the archipelago by the Visayan Islands or by Mindanao before following the paths in the China Sea, as indicated by the director of the observatory of Hongkong. In confirmation of this we only need to record the typhoon of June 7 to 12, 1895, which placed the merchant vessel *Bohol* in such danger just north of Panay, as was recorded in the meteorological review of our monthly bulletin for that month and year. Concerning this the director of the observatory of Hongkong, in his work The Law of Storms of the Eastern Seas, in speaking of those typhoons which traverse our archipelago and enter the China Sea at latitudes below 15°, and which are moving from the W. or WNW., says that they occur in about 3 per cent of cases, whereas we have records of ten baguios of this type, or 11 per cent, solely during the four years 1895 to 1898, inclusive.

[2] Baguios or Philippine Cyclones, pp. 17 to 19.

[3] The author had on the previous page indicated this division of the year into groups in the following words: "For this purpose we may consider the year divided into three groups, as follows: December, January, February, and March constitute one group; April, May, October, and November another; and June, July, August, and September the third."

June–September.—The zone of formation of the baguios of this third group lies between the eighth and twentieth parallels north latitude, and the one hundred and thirty-second and one hundred and forty-fifth meridian east from San Fernando (one hundred and twenty-sixth to one hundred and thirty-ninth east from Greenwich).

EXCEPTIONS—ORIGIN OF THE BAGUIO OF AUGUST 1 TO 6, 1899.

We will simply add that these zones of formation of the cyclones of the Pacific are only probable, as the author himself so denominates them, and applicable to the majority of cases, and that it would not be in opposition to this if an occasional baguio should be formed outside of the limits indicated. Such was, for example, the typhoon of August 1 to 6, 1899, which, although it originated west of the Marianas, according to observations made in those islands and which are now in our possession, apparently had its origin to the east of the one hundred and thirty-ninth meridian east from Greenwich, the parallel indicated by Father Algue as the limit of the zone of formation of the baguios of June to September. This is indicated in the brief relation which we give of this typhoon in the monthly publication for the month of August, where, among other things, the following is said:

> At 6 p. m. of the 31st of July a change of weather was noted at the observatory, and the following extraordinary note was made: A slight fall of the barometer began; weather suspicious.

At 10 o'clock the following morning an announcement was made to the public, and to China and Japan, of a depression east of Luzon. According to valuable observations made on board the U. S. S. *Solace*, bound from Guam to Manila, for which we are indebted to the generosity of Mr. Everett Hayden, the typhoon was situated at noon of the 31st of July north of this steamer, not far from the one hundred and fortieth meridian east of Greenwich, and probably between the fifteenth and seventeenth parallels; that is, about 1,000 miles from Manila.[1]

On the 3d the observatory sent another announcement to the coast of China, indicating the path of a typhoon.

> August 3, 7 p. m.: "The typhoon in the Pacific seems to be ENE. of Manila, between 18° and 20°, moving, probably, WNW. or NW." So it proved. The baguio moved WNW. or NW. ½ W., reaching the continent night of 5th and 6th.

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[1] The observations referred to, made on board the steamship *Solace*, are as follows:

Extract from log of U. S. S. Solace, Guam to Manila.

Date.	Position.		Barometer.[a]	Winds.		Observations.
	Longitude.	Latitude.		Direction.	Force.	
	° ′	° ′				
July 31	140 03 E.	12 11 N.	29.69	SW. by S.	3–5	Cloudy, squally; gentle to very fresh breeze in puffs, WSW. to SW. by S.
Aug. 1	138 20 E.	11 11 N.	29.61	SSW.	6–8	Overcast, squally; fresh breeze to moderate gale from SSW.; rough sea from SW.
Aug. 2	136 30 E.	11 14 N.	29.73	SW.	7–8	Overcast and cloudy, with passing showers; fresh breeze increasing to strong gale in heavy squalls.
Aug. 3	133 43 E.	11 46 N.	29.76	SSW.	6–8	Cloudy and squally, with passing showers; moderate gale; squally.
Aug. 4	130 41 E.	12 42 N.	29.83	SW.	5–6	Clearing somewhat; stiff to fresh SW. breeze; long southwesterly seas.

[a] These barometer readings are between 0.08 and 0.016 too high; the error is not exactly known.

VI.—CLASSIFICATION OF BAGUIOS. DIVISION OF THEIR PATHS INTO 11 PRINCIPAL TYPES.

OBJECT AND AIM OF THIS CLASSIFICATION.

There are various systems which may be followed in classifying baguios, but one of the most adequate seems to be that followed by Father Algue, founded on the course of their trajectories, as may be seen in the work Baguios on Philippine Cyclones, page 142.

We give here, nevertheless, a somewhat different classification, not because we believe it the best or most perfect, but only because it seems to us most adequate and suitable to the objects which we have stated in this paragraph. This is to present in 11 maps 11 groups of baguios which have been well studied and which may be reduced to 11 principal types, attention being paid to their formation and to the diversity of their paths, graphically indicating at the same time the relative intensity and change of the winds which may be expected in Manila when a baguio appears, according to whether it belongs to one or the other of these 11 principal types.

CLASSIFICATION OF THE CYCLONES OF THE EXTREME EAST WITH SPECIAL REFERENCE TO THE INFLUENCES WHICH THEY EXERT IN MANILA, ACCORDING TO THE ZONE OF FORMATION AND THE CURVE OF THEIR PATHS.

It happens that our classification includes all the cyclones of the extreme East, but it is made principally with reference to Manila, or to the influence exerted on Manila according to the zone of formation and the course of the trajectories.

On this basis we divide or classify all baguios in the following form:

- Cyclones formed in the Pacific.
  - Cyclones of the Marianas or Magallanes.
  - Cyclones of Japan.
    - Those which recurve far from the meridian of Manila.
    - Those which recurve near the meridian of Manila before or after crossing it.
  - Cyclones of Formosa.
  - Cyclones of the Philippines.
    - Cyclones of Luzon.
      - Cyclones which cross to the N. of Manila.
        - Cyclones which recurve in the interior of Luzon, or in the China Sea, not far from the island.
        - Cyclones of China, Tonquin and Cochin China.
      - Cyclones which cross to the S. of Manila.
    - Cyclones of the Viscayas and Mindanao.
    - Cyclones which recurve in the China Sea between the 10th and 20th parallels north latitude, crossing first to the south and then to the north of Manila.
- Cyclones formed in the China Sea.
- Cyclones formed in the Jolo Sea or the interisland waters S. of Luzon.

Of the baguios, which we shall study in this chapter, 81 per cent belong to the first main branch of this division, 15 per cent to the second, and only 4 per cent to the third.

Of the typhoons of Visayas and Mindanao, those formed in the China Sea and those formed in the sea south of Luzon, some disappear in the China Sea before reaching the continent, while others, greater in number, penetrate it in the south of China, in Tonquin, or in Cochin

China. Those formed in the China Sea very seldom go in the direction of Formosa or Japan. But this is not true of those of Visayas and Mindanao, which in this case belong to the last of the three groups of baguios, which we have called Philippine baguios because they cross these islands.

In regard to the subdivisions which we have made of those baguios formed in the Pacific, we have the following observations to make: First, that the cyclones which we call those of the Marianas or Magallanes are those which disappear in the Pacific without reaching our archipelago or recurve in such a manner that the second part of their parabolic trajectory does not carry them to Japan nor near it, but rather in the direction of the archipelago of Magallanes; second, that we understand Japanese typhoons to include, not only those which actually traverse Japan, but also those which, after recurving, pass through the seas of Japan or in the vicinity of that Empire; third, that by cyclones of Formosa, Luzon, Visayas, and Mindanao we understand all such as traverse said islands, or at least cross not far from them, some in the direction of the east coast of China, others in the direction of the China Sea, whether or not they reach the continent.

PATHS OF THE CYCLONES OF THE EXTREME EAST REDUCED TO 11 PRINCIPAL TYPES—GRAPHIC REPRESENTATION OF THE VEERING AND INTENSITY OF THE WINDS WHICH ARE TO BE EXPECTED IN MANILA WITH BAGUIOS OF EACH ONE OF THESE TYPES.

The 11 accompanying maps are made in accordance with this classification, and in them the trajectory of the cyclones of the extreme east may be seen reduced to 11 principal types. In each one of these maps we have graphically represented, by means of arrows, the relative intensity and veering of those winds which may be expected in Manila whenever a baguio of that particular type occurs. The Roman numerals I, II, III, placed by the side of each arrow, indicate the order of procession of those winds, or the way in which they should veer from the beginning to the end of the supposed trajectory. The number of barbs on each arrow indicates the relative intensity of the winds; that is to say, which winds usually acquire greatest force with the trajectory of the type under consideration. We represent only the relative intensity, because the absolute intensity of these winds depends upon many causes. In our opinion the three principal causes are: The minimum distance at which the vortex crosses, the greater or less development of the typhoon, and the inclination of the axis of the storm to one side or other of the trajectory. We repeat the map of Plate XLVII with the object of giving a greater number of trajectories of baguios which during the last two years have crossed the island of Luzon to the north of Manila.

The trajectories of those baguios, given in Plate L, may be subdivided into two classes, namely, those which pass nearest to Manila in the first part of their parabolic path; that is to say, those that cross to the south; and those which, on the contrary, pass nearest to Manila when they cross our meridian on the north, after having recurved in the China Sea. The veering of the winds, which may be expected in Manila with each of these classes of baguios, is much clearer in the second than in the first. It may happen that the veering of the wind will not be greater than toward the S. or SSW., especially if the baguios run far into the China Sea before recurving. But the difference is even more notable in the relative intensity of winds. Those in the first case naturally acquire greater force if from the E., ESE., and SE., being very weak and light if from the third quadrant. On the other hand, when the baguio passes nearer and crosses the north, the winds are strongest when from the SW. and WSW., while those from the second quadrant are light or brisk in character. With the object of making this latter difference prominent in Plate L, we have distinguished certain trajectories from others by the letters A and B, placed in the vertex of the parabola, thus giving in two distinct diagrams the different relative intensities of those winds which correspond to the two classes of trajectories.

We will conclude this paragraph by stating that we have been very careful to select trajectories of the last two years, especially of the period 1895 to 1899, and that in general we have taken them from those months in which baguios of each one of these types are most frequent.

VII.—PRECURSORY SIGNS OF BAGUIOS.

PRINCIPAL PRECURSORY SIGNS OF BAGUIOS.

It being impossible to discuss this subject with the fullness that it merits, we can not do better here than recall to mind something of what Father Faura and Father Algué have written upon this subject.

The principal precursory signs of a baguio are those offered by the nebulosity of the atmosphere, the movements of the barometer, and atmospheric currents combined with each other.

By means of the movements of the barometer an individual observer may assure himself of the existence of a cyclone, but he can not locate its position, as he might easily do if, to the sign given by the barometer, he should add one of the other two founded on the nebulosity of the atmosphere or the atmospheric current. It is a very different matter if we have a first-class observatory provided with a good meteorological service in a determined region. Under such circumstances the simple readings of the barometer of the different stations compared with each other enable an observer to easily trace the isobars, note the barometric inclination, and locate therefore the vortex of any baguio which is approaching that region.

SIGNS FROM ATMOSPHERIC CURRENTS AND MOVEMENTS OF THE BAROMETER.

In the following paragraph we shall see how the different currents of the atmosphere are established in the vicinity of a cyclone, and how valuable this indication may be for locating the condition of a cyclone, especially when the barometer has made us certain of its existence.

A practical method of utilizing the movements of the barometer as a precusory sign of a tempest may be seen by our readers in paragraph 10, where we make mention at the same time of the apparatus invented by Father Faura and Father Algué, for forecasting the weather in the Philippines and in the extreme Orient.

SIGNS FOUNDED UPON THE NEBULOSITY OF THE ATMOSPHERE AND ESPECIALLY UPON THE CONVERGENCE OF CIRRUS CLOUDS.

In regard to the other sign, founded upon the nebulosity of the atmosphere, and especially in regard to the convergence of cirrus clouds—a sign much more valuable when it comes, as it does at times, one or two days before the other two—we believe that nothing can be added to the lines written by Father Faura, in 1881, in his popular leaflet entitled "Precursory signs of tempests in the Philippine Archipelago," which are as follows:

AUTHORITY OF P. FAURA—PRACTICAL INSTRUCTIONS FOR THE CERTAIN USE OF THIS SIGN.

The best method of determining the position of the vortex and following its various movements is the observation of high cirrus clouds, little clouds of very fine structure and clear opal color, which appear as elongated feathers, and which are known to mariners under the name of "cock-tails." The first idea of utilizing these clouds for the determination of the vortex of the storm is due to Father Benito Viñes, director of the Habana observatory, and, according to our opinion, it is one of the greatest conquests obtained in the study of meteorological phenomena during the past few years. It must be confessed, nevertheless, that they do not present themselves here with the clearness attributed to them by the author mentioned, and for this reason we shall stop a moment to describe the characteristics which they usually present in our archipelago. Long before the least sign of bad weather is observed, and in many cases when the barometer is still very high and under the influence of the center of maximum pressure, which usually precedes a tempest, these small, isolated clouds appear in the upper region of the atmosphere. They seem to be piled up on the blue vault of heaven, and are prolonged in the direction of some one point on the horizon, toward which they converge. The first of these are few in number, but well defined and of the finest structure, appearing like long filaments bound together, but whose visibility is lost before reaching the point of convergence.

At the observatory of Manila they have been seen at times when the vortex of the storm was more than 600 miles distant. As soon as they are observed it is necessary to keep them in sight and carefully watch the successive movements which they make.

The best time for making this observation is the moment that the sun rises or sets. When the sun approximates the eastern horizon the first clouds to be colored by its rays are the cirro-stratus, the precursors of bad weather; on the other hand, they are the last to disappear after the sun has passed behind the horizon. Having determined with great care the point of convergence of said clouds during these moments, the direction of the position of the vortex of the tempest can be approximately determined. Later these clouds become much more numerous, but lose in part that fineness which characterizes them at the beginning. They are in general more condensed and appear in fanciful forms, now like trees, and now like feathers, with shafts and plumes, without, however, losing their peculiar position, from which it is still possible to estimate the position of their point of convergence.

To determine approximately the direction of the center of the tempest in its progressive movements it is necessary to estimate at regular intervals the various points of convergence of these cirro-stratus clouds and compare them with the movements of the barometer.

Let us suppose that the point of convergence toward which these clouds gather, or toward which they tend to gather, if they are seen throughout their entire length, lies in the second quadrant, which is the only situation which may become dangerous for an observer situated to the west of the tempest. If the point of convergence does not perceptibly change its position, but remains fixed and immovable for a long time, even for several consecutive days, it is almost certain that the tempest will break over the position of the observer. In this case the barometer begins to fall shortly after the first cirrus cloud has been observed and sometimes before. At first it falls slowly, without completely losing the diurnal and nocturnal oscillatory movements, but changing somewhat the hours of maximum and minimum reading. The mean daily reading is observed to be each day less than that of the preceding day. That part of the horizon in the direction of the tempest begins to be covered by a cirrus veil, which increases slowly until it forms almost a homogeneous covering to the sky. This veil is known by the name, cirro-pallium, of Pöey, and is that which causes the solar and lunar halos, which are never absent when a storm approaches.

Beneath this veil a few isolated clouds, vulgarly called "cotton," now appear. They are much more numerous and also larger on the side lying toward the tempest, where they soon appear as a compact mass. Surprising red colors are then caused by the rising and setting sun, the clouds sometimes taking this color and resembling a great fire, chiefly in the direction of the cyclone.

The colors are not homogeneous, but often present a marked gradation, the most compact part being very deep red, the cirrus veil being much lighter in color, and finally the cirro-stratus above the veil being colored with still lighter tints, and, as already has been said, they are usually the last to disappear.

If a careful observation is taken at this moment, it will be seen that the cirro-stratus clouds form an arc at the point where they are intercepted by the darkest part of the cloud. The vertex of this arc exactly corresponds to the direction of the center of the storm. In the case already supposed, that is to say, when the direction of the cirro-stratus clouds has not changed after all the phenomena described, it may be taken as certain that the tempest will approach directly toward the observer. The barometer then completely loses the diurnal and nocturnal oscillations; instead of rising at the hours indicated, it falls, or at least remains quiet if the storm is of little importance, or slow in its progress.

The wind remains fixed at one point, generally between the NE. and NW., showing only a few oscillations, which are due principally to the squalls, which continually exert their force within the limits of the storm. If the observation is made on land, or in some place near to it, this oscillation may be the effect produced by breaks in the mountains. The low or cotton clouds return successively, and from time to time cover the sky, throwing out occasional squalls of rain and wind, but, when the squalls have passed, tranquility returns, the cirrus veil, already spoken of, remaining, and likewise the hurricane bank of clouds, which seems to be fixed in the same point on the side of the tempest. This state of the atmosphere continues until the bank of clouds invades the point of observation, in which case the squalls will be continuous and the wind will increase in violence each moment. The phenomena occurring during the height of the tempest need not be described as they are so well known.

This first supposititious case, although most to be feared, is also most rare, and very easy of observation, because the character of the phenomena indicated is clearly marked; this kind likewise is most easy to escape. Suppose, again, that the first cirro-stratus clouds are observed converging toward the second quadrant, to the SE., for example, and instead of the point of convergence remaining fixed, as in the first case, it successively changes its position. If this change is notable, it may be considered certain that the observer is outside of the trajectory. If it changes to the SSE. and S., the vortex of the storm will pass to the S. and SW. of the observer; if it changes to the ESE. and E., the vortex will pass to the NE. and N. The phenomena of the cirrus veil, the solar and lunar halo, the coloration of the cloud by the sun's rays, etc., will also be present, but somewhat modified, according to the position of the vortex of the storm.

The best method, then, for determining the extent to which the storm may affect the observer is the comparison of the movements of the barometer with the rapidity with which the location of the point of convergence of the cirro-stratus clouds changes. If the point of convergence reaches the east or the south without the barometer having felt its influence, and without complete alteration of the diurnal and nocturnal oscillations, it may be considered certain that the storm will only touch the circle or cut a small cord of it. In this case only puffs of wind will be felt, or winds from the third quadrant if the vortex passes from the east, or from the second quadrant if it passes from the south. The veering of the winds takes place with regularity and in accordance with the known law of storms, those from the fourth and first quadrants being light, while those from the third or second are more brisk and accompanied with showers. These, as we have already said, are, in our opinion, the winds which constitute the phenomenon known here by the name of "collas."

METHODS FOR DISTINGUISHING THOSE CIRRO-STRATUS CLOUDS WHICH ARE REALLY THE PRECURSORS OF A STORM FROM THOSE WHICH ARE NOT.

Father Faura, in the description of the tempest of the 4th and 5th of November, 1882, enlarges somewhat on this point, giving certain methods of distinguishing those cirro-stratus clouds which are the precursors of a tempest from those which are not. He says:

> Before continuing, we believe it will be useful to make some indications concerning the observations of those cirro-stratus clouds which are spoken of under "Signs." This kind of clouds should not be confounded with those which appear so frequently in these localities whenever a storm approaches, nor with those which occupy almost the entire horizon when the winds from the north are blowing in the upper regions of the atmosphere. The precursory cirro-stratus clouds of a cyclone are distinguished from those of an ordinary storm by the persistence with which they remain on the horizon. Those belonging to a storm or passing squall disappear when they have expended their force. On the other hand, those belonging to a cyclone persist for a long time, sometimes for several consecutive days. They are distinguished also from those caused by general currents in the upper region of the atmosphere by their convergence, as those due to general currents are scattered here and there many times

without any indication of convergence or with indications of convergence in various directions, and at other times when some convergence is present it is very difficult to make it out, and very different from that of cirro-stratus clouds belonging to that class of storms of which we speak. This latter is so characteristic and so easy of observation that a simple inspection of it immediately directs the attention to the vortex of the cyclone. The appearance is often similar to a fan, the point of convergence being toward that side of the horizon where the center of the cyclone lies.

NOTABLE EXAMPLES OF CIRRUS CONVERGENCE.

If the pressure of time would permit, we should with pleasure present here a catalogue of the times when, in Manila and in other points of the archipelago, this convergence of cirrus clouds is stated to have been observed in the anterior or posterior part of a cyclone. But as this is impossible now, we shall content ourselves by remembering a few of the most notable examoles which we find in the monthly bulletins of this observatory.

TYPHOONS OF OCTOBER 12–13 AND 19–20, 1881

In the month of October, 1881, two cyclonic vortices presented themselves by way of the Pacific Ocean, the first crossing the center of Luzon the night of the 12th–13th, and the second the night of the 19th–20th. Both were moving in a northwesterly direction when they crossed the island; but whereas the former followed the same direction in the China Sea, entering the continent to the W. of Hongkong, the other turned completely to the W., when it had scarcely left Luzon, and passed S. of Hainán on the 23d. Now, then, see what is read in the general observations published in the bulletin of this observatory corresponding to said month and year:

Day 10.—"Cirrus sky all through the day; in the morning it caused a beautiful solar halo; some featherlike tufts of cirro-stratus converge to the ESE. (toward this point of the compass there was a cyclonic vortex)."

Day 13.—"This morning there already appears the cirrus veil of the posterior part of the storm. Drizzling rain at dawn. Persistent cirrus veil until afternoon; above the same are discerned some well-defined cirro-stratus clouds converging to the NW.; the storm is in this point."

Day 16.—"Sky covered and at times clear; tufts of cirro-stratus in the late afternoon, converging to the SSE.; the night comes in clear and beautiful, without on this account pluniform cirrus ceasing to exist in the indicated direction (toward which another cyclonic vortex was appearing); during the night a very dense cirrus veil began to extend itself under the cirrus, and in the early dawn it occasioned a slight lunar halo."

Day 20.—"The storm continued throughout the day, because of the slowness of its forward movement. At nightfall it ceased with some squalls from the SSW., notwithstanding the winds continued veering to the SE. This morning a multitude of cirro-stratus appear in the form of gigantic pendants, all converging to the WNW.; there the storm is at present. At sunrise they were all colored a deep orange color, which gave the atmosphere an agreeable aspect."

TYPHOON OF NOVEMBER 4–5, 1882.

It was possible to observe from the observatory another well-defined convergence in the fore part of the typhoon which was experienced in Manila on the 4th and 5th days of November, 1882.[1]

This is how Father Faura describes the phenomenon in his "Brief notes on the storm of November 4 and 5, 1882, on its passage through Manila:"

> The first indications which the storm gave appeared at 9 o'clock in the morning on the 3d; the barometer at this hour stood at the height of 759.92 mm., certainly very far from indicating by itself that such a phenomenon existed, and for this same reason we could not make use of it to predict it; but there were discerned in the high regions of the atmosphere a multitude of cirro-stratus in the form of long and pointed filaments, which were seen to converge toward the ESE., cumulus clouds being also seen, scattered here and there all over the horizon, to cross under them, forming almost a right angle. At first we thought that the cirro-stratus were formed by a whirlwind which was forming on the eastern horizon; but on noting during many consecutive hours their persistence on the horizon, and that they were increasing by the minute instead of diminishing, we became convinced that they were due to some more tenacious and important cause than a simple and passing whirlwind. At 11 o'clock a light cirrus veil began extending itself underneath the cirro-stratus, giving rise to a beautiful solar halo, which remained the rest of the day and was always visible when the numerous and heavy cumulus clouds, which frequently covered almost the whole sky, crossing, as we have said before, at right angles underneath the plumiform cirro-stratus clouds, left open that part of the atmosphere where it was formed. The barometer from 759.92, where it stood at 9 in the morning, fell to 756.58 at 3 and 4 in the afternoon—that is to say, more than 3 mm.—which indicated, as per 9 of "Precursory storm signals," that an atmospheric disturbance was near. With impatience we awaited the setting of the sun, and this was truly surprising and brought us out of the perplexity in which we found ourselves. From the NE. to the SE. the clouds in the vicinity of the horizon began to be colored with a dark but intense red color; as the sun sank below the horizon the highest clouds became red also but lighter and brighter; the whole resembled a vast fire; finally, the cirro-stratus appeared in the shape of a fan, as we have seldom seen them, ruddy with a still lighter color, which approached an orange yellow, and forming toward the point of convergence, where they were intercepted by the clouds which occupied the eastern horizon, an arch, whose vertex could be perfectly defined; said vertex was exactly to the ESE.
>
> This obliged us to immediately send a notice to the newspapers of the capital so that all might know of the terrible enemy that we had so near. * * *

TYPHOON OF OCTOBER 2–3, 1894.

From the 2d to 3d of October, 1894, a typhoon of great severity crossed through the center of the island of Luzon, which, after having moved to the height of 20 north latitude in a direction toward WNW., then turned to the north, entering the continent near Hongkong and Macao, for which colonies it appears that this typhoon was the most severe they had experienced since the sadly famous one of 1874. Now, then, from this observatory we had the opportunity to view a beautiful convergence of cirro-stratus toward the NW., which lasted for some time, the morning of the 4th day of October, reappearing at 5 in the afternoon The vortex of the cyclone was then precisely in the China Sea to the NW. of Manila

TYPHOON OF JUNE 1, 2, 1896.

We could cite many other cases of convergencies of cirro-stratus observed, not only in this observatory, but also at other points of the archipelago, especially in the meteorological station of Aparri, in whose records we have frequently seen this phenomenon entered, precisely toward those points of the compass where it is certain that there was then a cyclonic center. Thus, for example, the 1st of June, 1896, a cyclonic vortex was to the ENE. of Aparri and NNE. of Surigao, which recurved in the Pacific itself between parallels 20° and 30° and meridians 125° and 130° E. Greenwich, and, in spite of the influence of this typhoon having been insignificant in the archipelago, we find a convergence of cirro-stratus to the ENE. noted at the Aparri station, and to the NNE. at the Surigao station.

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[1] See the trajectory of this typhoon in Plate XLVII, paragraph VI of this chapter.

THE HURRICANE WAVE.

We are going to end this paragraph by indicating another precursory sign, which we consider of capital importance for mariners, because it precedes the typhoon as much or more than the convergence of cirrus clouds, and because it is, perhaps, in the Philippines more easily observed, and it presents itself with more regularity than said convergence. We refer to the hurricane wave.

NATURE AND DIRECTION OF THE HURRICANE WAVE.

In the notes relative to the hurricanes of the Antilles[1] Father Viñes describes the nature and direction of the hurricane wave in these words:

> The great depression which originates in the interior of the meteor, especially toward its central region, causes the hurricane to act by aspiration on the waters and raises and suspends them in quantity proportional to the excess of the external over the internal pressures in a manner analogous to what takes place in the air pump from the time when a partial vacuum begins to be produced in the body of the pump. The impulse of the revolving, converging winds contributes to this same effect, producing converging currents in the sea which tend to heap up the waters at the vortex of the cyclone.
>
> The waters accumulated under the influence of these two causes form the so-called hurricane wave, a pyramidal and deformed wave, whose crest or vortex corresponds approximately with the vortex of the cyclone. This immense wave always accompanies the meteor in its movement of progression, and on being thrown against the coast, it makes the water rise to an extraordinary and sometimes astonishing height, causing terrible inundations and spreading everywhere terror and desolation.

Here ends Father Viñes's description.

THE WAVE MOVEMENT IN THE FOREPART OF A CYCLONE PROCEEDS APPROXIMATELY FROM THE CENTER AND IS PROPAGATED TO GREAT DISTANCES.

Father Algué, in page 123 of Typhoons or Philippine Cyclones, summarizes into these two or three conclusions what relates to the hurricane wave and wave movement, taken as a precursory sign of a typhoon:

> As to the hurricane wave movement, numerous facts confirm—
>
> 1. That in the part before the vortex the wave movement proceeds approximately from the center.
>
> 2. That it is propagated to very great distances, attaining in its course strength varying in proportion to the distance.
>
> We would state that in case of meeting any great obstacle resultant directions are observed, which, although explicable in some cases, are not always easy to foresee or interpret.
>
> Concerning the hurricane wave, experience teaches us that it is the cause of the greatest destruction on the coasts and on the high seas.

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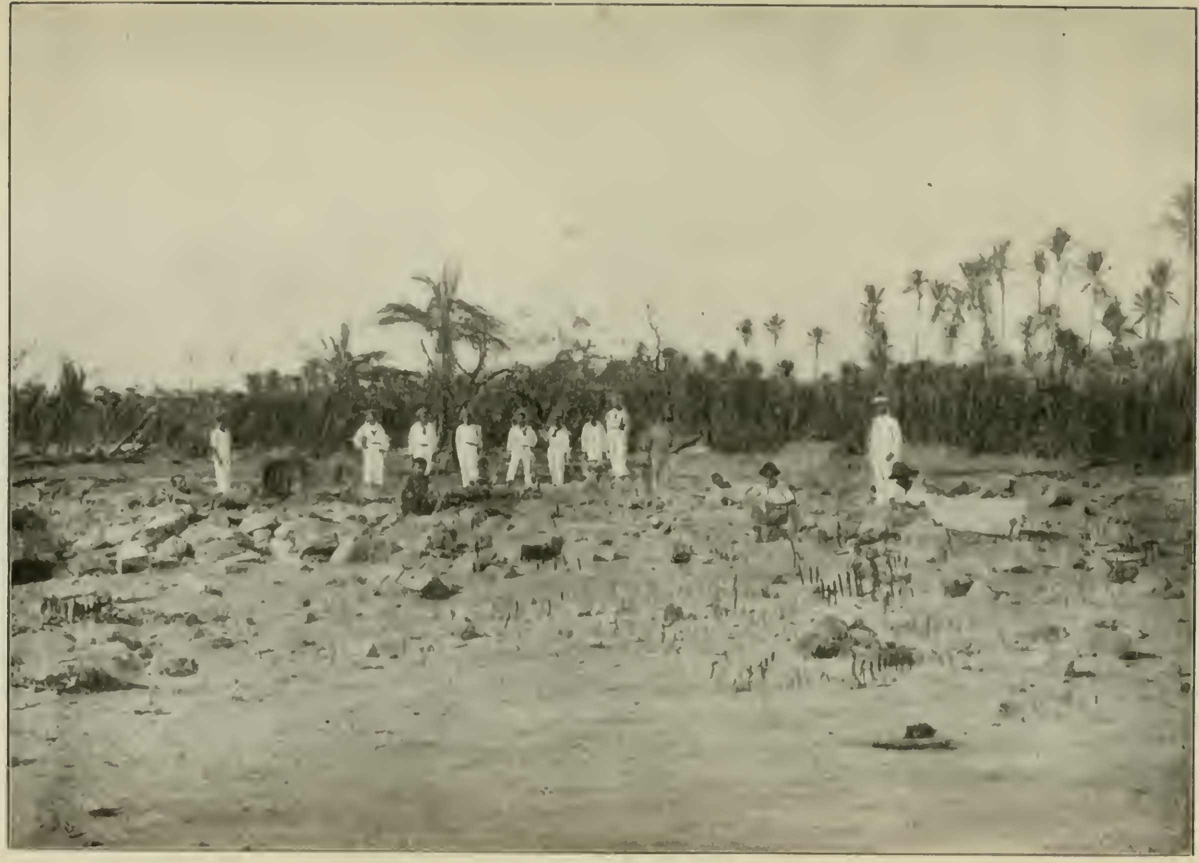
[1] Page 192.

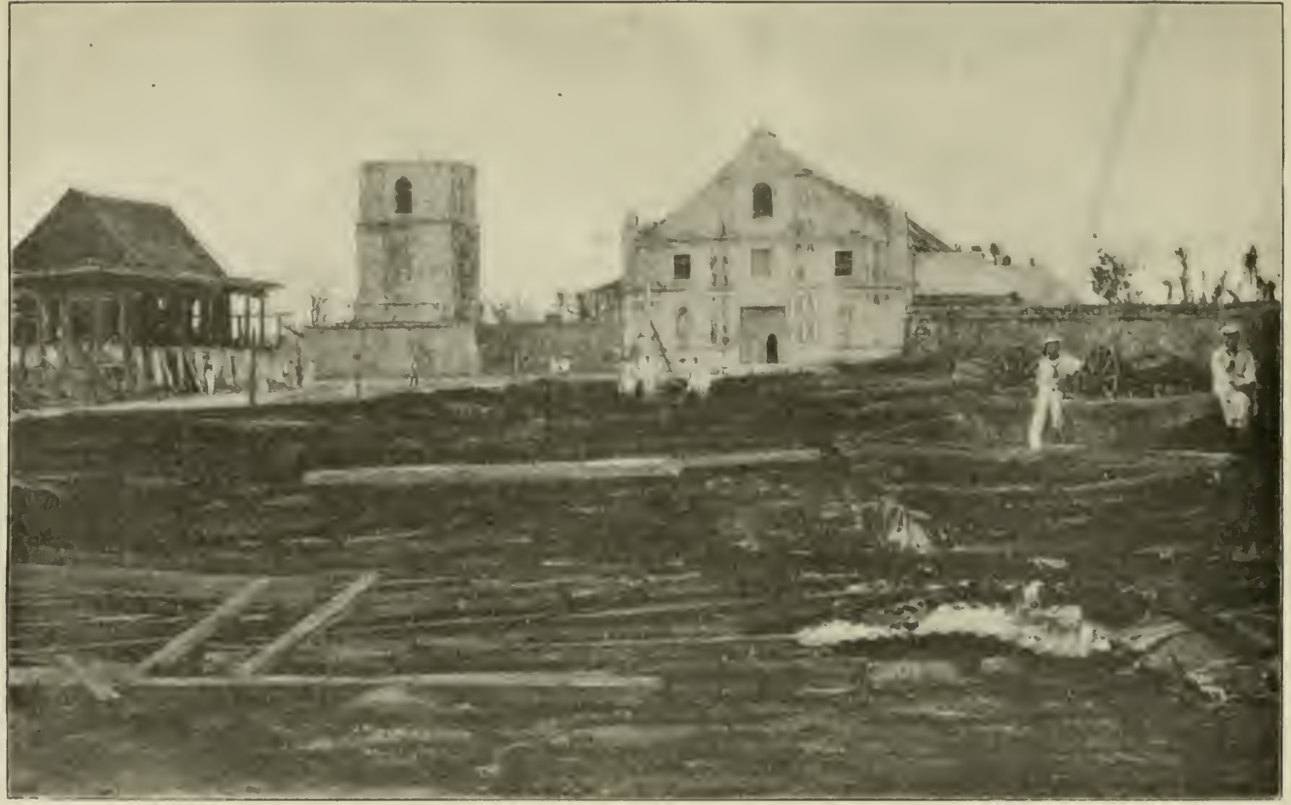
PLATE LIII.



TYPHOON OF OCTOBER 12, 1897.

Ruin caused by the wave movement in Hernani (Samar)

PLATE LIV.



TYPHOON OF OCTOBER 12, 1897.
Ruin caused by the wave movement in Guiuan (Samar)

It must be stated that the same Father Algué had a little before distinguished the hurricane wave from the hurricane wave movement with these words:

> In order to avoid confusion, it is necessary to distinguish the hurricane wave, which is properly what we have defined; that is to say, an immense mountain of water heaped up in the vortex of a cyclone, which follows the same vortex in its progressive movement, and what may be called the wave movement of the hurricane; that is to say, the wave movement occasioned by said wave. The wave can not be taken as a precursory sign. The wave movement of the hurricane is properly an indirect precursory sign, of which we shall treat more particularly. The Spanish authors speak indiscriminately of both, designating both phenomena by the generic name of hurricane wave.

In confirmation of what Father Algué affirms, proving it at length in the place cited, see what had been written a little before by Father Luis Froc, director of the Observatory of Zikawei, in a valuable pamphlet entitled The Yltis Typhoon. After said father had brought forward many documents to prove that in the semicircle preceding the Yltis typhoon the hurricane wave movement came from the vortex and was felt at great distances, he ends his argument with the following words:

> It is evident that the point in question is not a local accident, but a general and constant fact which belongs to the very constitution of a cyclone. Along the coast of China, from Foochow to Shanghai, in the Yellow Sea and in the Sea of Japan, not less than to the south of Korea and opposite the islands of Goto, a marked wave movement was observed from the center, at a distance of at least 500 miles, in all the semicircle in the fore part of the trajectory. Is the same phenomenon reproduced in the posterior semicircle and at the distance indicated? Observations are lacking to prove it, and this question is of little importance compared with that of the prediction of typhoons. * * * Practically there is no doubt that one of the first indications of a cyclone is given by the extraordinary wave movement, which can not be attributed to the wind, which by its presence not only indicates the existence of the center of perturbation, but also its movement. The attentive observation of the direction of the wave movement and of its slightest variations, especially at seasons or places liable to typhoons, can never be sufficiently recommended to the careful mariner, and special mention and weight should be given to this observation in the ordinary observations. It is clear that any agitation on the surface of the ocean should not be regarded as a sign of distant perturbation, but if such agitation is noted at a time when other previous or subsequent signals also give an indication of perturbation, the signs corroborate each other and will give a more definite solution of the two questions: Where is the danger? and What is its extent?

HAVOC WHICH THE HURRICANE WAVE USUALLY OCCASIONS—TYPHOON OF OCTOBER 12, 1897.

Concerning the havoc which, as Father Algué says, the hurricane wave may occasion, especially on the coast, I think it is sufficient to briefly record what occurred in Sámar and Leyte during the terrible typhoon of October 12, 1897, the trajectory of which may be seen in Paragraph VI of this chapter, Plate XLIX. The same Father Algué, in a memorial which he published, giving a full account of events entitled "The typhoon of Sámar and Leyte," described at length the victims of and the ruin caused by the hurricane wave which accompanied it, and we, in the Meteorological Review of the Monthly Bulletin of this observatory, corresponding to said month and year, summarized the most important facts in these terms: "The destruction caused by the fury of the winds in the settlements in the southern part of Sámar and the central and northern part of Leyte, which successively were found within the destructive zone of this typhoon is indescribable, but the ruin which the hurricane wave caused on the eastern and western coasts of South Sámar, and on those of Leyte and Sámar which form the bay of St. Peter and St. Paul, was incomparably greater. It is enough to say that in Tanauan the water rose 3 meters above the average sea level; 3.9 meters in Tacloban (latitude 11° 14′, longitude E. Greenwich 125° 6′); 4.6 meters in the cove of Panirugan to the north of Tacloban; 4.9 meters in Vasey (latitude 11° 16′, longitude E. Greenwich 125° 9′); 5 meters in Punta Calapines (latitude 11° 5′, longitude E. Greenwich 125° 19′); 3 meters in Guinan; 5 in Tanglad (latitude 11° 21′, longitude E. Greenwich 125° 40′), and 7.3 in Hernani (6 kilometers to the north of Tanglad), remaining at this height in this latter place for the space of some three hours. With this it is not at all surprising that the number of victims in Sámar and Leyte of the hurricane wave alone amounted to some 1,300 persons.

The three Plates LIII, LIV, and LV[1] will aid in forming some idea of what we have just said regarding the destruction caused by the hurricane wave which accompanied the typhoon of October 12, 1897. In Plate LIII we see the place where formerly part of the town of Hernani (eastern coast of Sámar) stood converted into a sandy waste. There only remained a few poles, inclined to the NW. and to the WNW. by the force of the currents of the wave from the SE. and ESE. Plate LIV represents the plaza of Guinan, a town situated in the southern end of Sámar. In it are seen everywhere the relics of the typhoon—the church unroofed, the bell tower half destroyed, the courts and the schools, which were at the right of the church, completely ruined. The nipa palm-leaf house at the side was posterior to the typhoon. The wave cast a small boat more than 100 meters from the shore, and the fury of the wind lifted up and threw down on it two carts, as they appear beside the two seated sailors.

Finally, in Plate LV, the destructive effects of the wave on the church and convent of Hernani are seen, taken from the side toward the sea. Across the convent may be seen something of the ward of Santa Bárbara, which was entirely destroyed, as was all the rest of the town. The poles that remained standing were inclined to the WNW. by the force of the big wave.

VIII.—ATMOSPHERIC CURRENTS AROUND A TYPHOON.

LAWS OF CYCLONIC CIRCULATION.

With incredible brevity and precision, Father Benito Viñes, in a valuable work which he presented to the meteorological congress of Chicago in 1893, regarding hurricanes in the West Indies, described the laws of cyclonic circulation. And as all of it is of the greatest interest, and almost wholly applicable to the cyclones of the Far East, we have thought it appropriate to reproduce it here, at least in a great measure, as Father Algué also reproduced it in his work, Typhoons or Philippine Cyclones, pages 21–27. Father Viñes, therefore, says the following:

> 1. *General law of cyclonic rotation.*—The aerial currents in a cyclone form a vast whirlwind about a central space of relative calm, called the vortex of the cyclone.
>
> Now, then, it is a constant fact that the direction of the rotation is always the same in the same hemisphere. In our hemisphere the cyclonic rotation is always from right to left in direction E. N. W. S., or, as is usually said, in a direction con-

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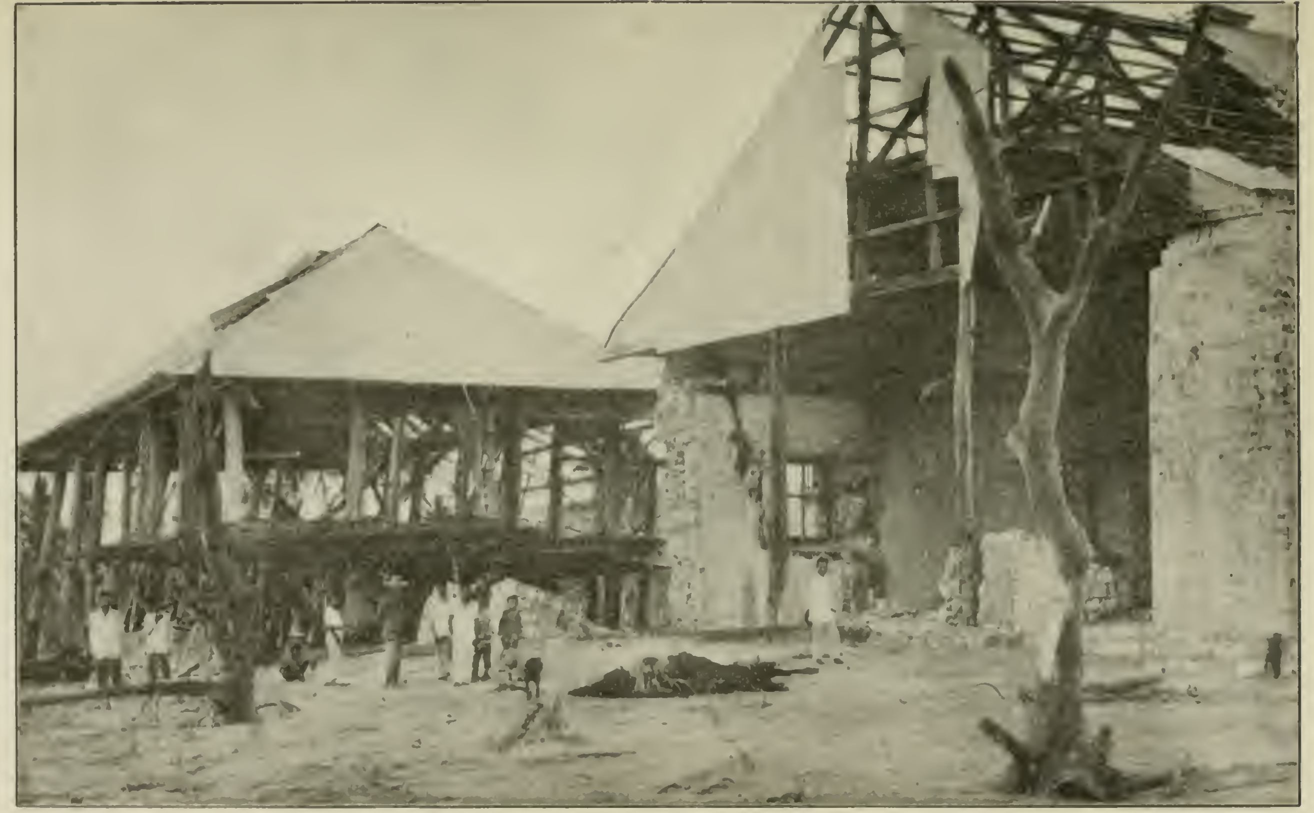
[1] The plates are taken from the memorial, "The typhoon of Sámar and Leyte."

Plate LV



TYPHOON OF OCTOBER 12, 1897

Ruin caused by the wave movement in the church of Hernani (Samar).

trary to the movement of the hands of a watch placed on a horizontal plane, and with the face upward. In the Southern Hemisphere the cyclonic rotation is in the opposite direction.

2. *General law of cyclonic currents at different altitudes.*—After a long experience of about twenty-three years of assiduous and most careful observation in a great number of cases and under very diverse circumstances I have been able to demonstrate with every proof that in the cyclones of the Antilles the cyclonic rotation and circulation act so that the inferior currents are generally more or less convergent toward the vortex; at a certain height they are almost circular, and at a greater height they begin to diverge, it being very noticeable that the higher the current is the greater the divergence, to such a degree that the highest cirrus clouds in many cases become wholly divergent, or go out in a radial direction.

So that if the vortex of the cyclone bears to the S. the wind blows approximately from the ENE., the lower clouds move from the E., the high cumulus clouds from the ESE., the dense cirro-stratus clouds from the SE.,[1] the cirro-cumulus from the SSE., and the light cirrus from the S.

This gradation of currents, which in a more or less perfect degree presents itself as a general and constant fact in the cyclones in the Antilles, even in those which are imperfectly developed and may be considered as simple cyclonic perturbations of little intensity, constitutes what I have called the law of cyclonic currents at different altitudes; a law which is truly wonderful, and which is doubtless based on the nature of the cyclonic movement itself and on the constituent mechanism of the tempest, and constitutes, to my mind, the fundamental law of cyclonic circulation.

But before proceeding to the thorough investigation and discriminative study of each one of the cyclonic currents in particular, it will be necessary to state that the degree of convergence or divergence of the different currents which form the constant gradation, and which I have established in the previous law, is generally variable in the different cyclones and at different sides, and in the different positions of the same storm; that is to say, according as the cyclone is of large or small diameter, of greater or less altitude, of great or little intensity, of more or less perfect organization; or according to whether the anterior or posterior part of the storm is being considered, or, finally, according to whether the vortex of the cyclone is located within the Tropics, or has been notably removed from them.

It should be noted that the angle which the different cyclonic currents form with the bearing of the vortex, according to whether the anterior or posterior part of the storm is being considered, varies according to a general law.

Therefore, let us see in the first place what the observation of each one of these two general cases tells us, provided the cyclone is located within the Tropics, or in the immediate neighborhood of the Tropics, and is suitably developed, displaying considerable energy in its currents.

A. *Anterior part of the storm.*—In the anterior part of the storm, and in general for winds from the north or those comprised between the E., N., and W., inclusive, the cyclonic currents are subject to the following particular laws:

(*a*) *Winds.*—In general the winds are convergent toward the vortex. So that, if we suppose that the observer is facing the wind, the direction of the center of the storm, or the position of the vortex, forms with the direction of the wind and to the right of the observer an angle greater than a right angle, or greater than 8 quarter points. The value of this angle is variable, and is usually comprised between 8 and 12 quarter points—that is to say, in some cases it is a little greater than 8 quarter points, and if extreme cases are excepted the greatest convergence does not usually exceed 12 quarters.

Consequently, in general a first approximation not to be despised in the determination of the position of the vortex will be obtained by supposing that the cyclonic winds have a convergence of 2 quarter points, or, what is the same thing, supposing that the bearing of the vortex forms an angle of 10 quarter points with the observed direction of the wind, so that if, for example, the direction of the wind is from the NE. it may be said that the vortex bears approximately to the SSE.

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[1] Regarding these cirro-stratus clouds of Father Viñes it is well to bear in mind the following remarks which Father Algué makes on page 158 of the work Typhoons or Philippine Cyclones; "We notice that the cirro-stratus or dense cirrus veil which Father Viñes considers as intermediate clouds (page 25) are not the cirro-stratus clouds of the international nomenclature, but the cirro-stratus clouds of Poey; although Father Viñes differs from Poey in supposing that his cirro-stratus clouds are at a less height than the cirro-cumulus, which are evidently intermediate clouds. Are such cirro-stratus clouds of Father Viñes equivalent to the high-stratus clouds of the international nomenclature?"

(*b*) *Low clouds.*—The low clouds move in directions approximately perpendicular to the position of the vortex. This intermediate current presents much more regularity than the inferior current, and the angle which it forms with the bearing of the vortex is much more constant and scarcely presents sensible variations when once the cyclonic currents are well established. So that to this current, before the cyclone, may be applied the laws of storms without any appreciable error in the generality of cases. The intermediate current which we are now considering includes the low cumulus clouds of a dark or lead color, the strato-cumulus, and the gyres of stratus and nimbus, which, within the tempest, move with great velocity. It is to be noted that the less dense and rather more elevated fracto-cumulus clouds which appear in the beginning are usually somewhat divergent.

(*c*) *High cumulus, cirro-stratus, cirro-cumulus clouds.*—The high cumulus, dense cirro-stratus, and light cirro-cumulus clouds diverge, forming with the bearing of the storm center acute angles, which are so much the less as the current is more elevated; that is, the current of the cirro-cumulus forms the least angle and the high cumulus the greatest, that of the cirro-stratus or dense cirrus veil being included between the two.

It is to be stated that the angles these currents make with each other and with the bearing of the vortex are far from being constant, the greater or lesser separation of said currents and the regularity with which they are disposed depending apparently on the degree of organization of the storm, and on the greater or lesser height and activity of the currents; so that in a well-developed cyclone of great intensity a remarkable regularity in said currents is ordinarily observed, not only as to the order in which they are always arranged, but also as to the magnitude of the angles which separate one from the other; and that in this case the high cumulus clouds usually make with the bearing of the vortex an angle approximating six quarter points, the cirro-stratus four, and the cirro-cumulus two.[1]

(*d*) *Cirrus clouds.*—Finally the light cirri, which are the highest currents subject to our observation, usually go out in a wholly divergent or radial direction, forming with the bearing of the vortex either no angle or a practically inappreciable one.

This current is among the most regular and in general forms a right angle with that of the low clouds.

Briefly reviewing what has been said, we find that the cyclonic currents which present the most regularity and those which best indicate the position of the storm center are that of the cirrus and that of the low clouds. The cirrus current is the preferable one to use from the time of the first indications of the proximity of a cyclone and when the vortex is still very distant. In the interior of the tempest the current of the low clouds is the one which should principally guide the observer. Lacking cirrus clouds, the currents of the cirro-cumulus or cirro-stratus clouds should be utilized; and lacking low clouds, those of the wind and high cumulus, always taking into account that their indications are not so sure, nor can they in general give such a good approximation. In a well-developed cyclone of great strength we generally find the following gradation and arrangement in the currents, and in a sufficiently approximate manner: If the vortex of the cyclone is to the SSE., the cirri move from the SSE., the cirro-cumuli from the SE., the dense cirrose veil from the ESE., the high cumuli from the E., the low clouds from the ENE., and the wind from the NE.

(B) *Posterior part of the storm.*—In the posterior part of the storm and in general for winds from the S., or those between the ESE., S., and WSW., it is observed that in general all the currents form with the bearing of the vortex angles greater than in the previous case, preserving, however, the same gradation between themselves. So that in the posterior part of the storm the inferior currents are generally more convergent and the superior less divergent than in the anterior part.

So it is that if the vortex, for example, bears to the NW., the wind is from the SSE. or S., the low clouds move from the S. or SSW., the high cumuli from the SW., the cirro-status from WSW., the cirro-cumulus from the W., and the cirrus from the WNW., approximately.

We, as a practical result of the observations made in this observatory, present the following table, in which we have included the typhoons that, in the period from 1880 to 1897, have influenced Manila with a barometric minimum of less than 753 mm., indicating in the respective columns the position of the storm center with respect to

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[1] According to the international nomenclature the cirro-stratus are included among the highest clouds, and therefore the law which Father Viñes gives later on for the cirrus clouds should be applied to them.

Manila in the hour of the minimum, the direction of the wind and low clouds observed in the observatory at that hour, and the angle formed by said directions, and the position of the vortex.[1]

TABLE CIX.—*Angle formed by the direction of the winds and low clouds with the bearing of the vortex at the time of the barometric minima of the most important cyclones observed from Manila from 1880 to 1897.*

Year.	Date.	Hour.	Barometric minimum.	Bearing of the vortex at the time of the minimum.	Wind at the time of the minimum.	Angle formed by the direction of the wind and the position of the vortex.	Low clouds at the time of the minimum.	Angle formed by the direction of the low clouds and the bearing of the vortex.
						°		°
1880	Sept. 21	3 p. m.	49.97	N. ¼ NE.	SW.	146	....	....
1881	May 24	1.30 p. m.	49.28	SW.	E. ¼ SE.	124	SE.	90
1881	June 28	8 p. m.	49.49	NE. ¼ E.	W. ¼ NW.	135	....	....
1881	July 13	4 p. m.	51.27	N. E.	WSW.	158	W.	135
1881	Aug. 19	8 p. m.	49.45	ENE.	WSW.	180	N.	68
1881	Sept. 6	4 p. m.	52.91	N. ¼ NE.	WSW.	124	W.	101
1881	Oct. 12	7 p. m.	52.38	NE.	SW.	180	WSW.	158
1881	Oct. 20	4 a. m.	49.20	N.	WSW.	113	WSW.	113
1881	Dec. 12	5 a. m.	51.55	S.	N.	180	E.	90
1882	Sept. 9	4 p. m.	52.70	NE. ¼ N.	WSW.	146	WSW.	146
1882	Oct. 20	11.50 a. m.	27.75	N.	WSW.	113	WSW.	....
1882	Nov. 5	10.20 a. m.	35.60	S.	NNE.	158	WSW.	....
1883	July 10	5 p. m.	50.64	NNE.	SW.	158	WNW.	90
1883	Oct. 28	12 p. m.	48.54	SW.	ESE.	113	WNW.	....
1883	Nov. 17	3 p. m.	52.88	SSW.	E.	113	E.	113
1884	July 10	4 p. m.	50.22	NNE.	SW.	158	WSW.	135
1884	July 27	2 p. m.	49.69	N.	SW.	135	....	....
1884	Aug. 20	4 p. m.	50.07	N.	SW.	135	WSW.	113
1884	Nov. 18	10 a. m.	47.75	N.	WSW.	113	....	....
1885	Aug. 23	3 p. m.	52.50	NE. ¼ N.	W. ¼ SW.	135	NW.	79
1885	Nov. 7	4.30 p. m.	48.68	ENE.	WNW.	135	NNW.	90
1887	Sept. 10	4 a. m.	49.22	NNE.	SW.	158	NNW.	....
1887	Sept. 19	3 p. m.	48.01	N.	SSW.	158	....	....
1887	Sept. 24	3 p. m.	48.39	N.	WSW.	113	W.	90
1887	Sept. 30	3 p. m.	52.73	NW.	SSW.	113	SW.	90
1888	July 14	3 a. m.	47.60	N. ¼ NE.	SW.	146	WSW.	124
1888	Sept. 27	5 a. m.	51.15	N.	WSW.	113	WSW.	113
1889	July 16	3 a. m.	52.10	NW.	SSE.	158	SW.	90
1889	Oct. 29	2 p. m.	51.03	SSW.	NNE.	180	ESE.	90
1890	Sept. 5	4 p. m.	52.37	N.	SW.	135	W.	90
1890	Sept. 30	1.50 a. m.	47.09	N.	SSW.	158	....	....
1890	Oct. 1	2.35 p. m.	52.00	NE.	SW.	180	....	....
1890	Nov. 11	12.54 p. m.	43.50	N.	SW.	135	....	....
1891	Nov. 13	5.10 p. m.	50.80	SSE.	NNW.	180	NE.	113
1891	Nov. 16	8.20 a. m.	48.50	S.	N.	180	NE.	135
1892	Oct. 9	4.45 a. m.	49.80	NE.	WSW.	158	NW.	90
1892	Oct. 28	2.03 p. m.	53.09	NE.	SW.	180	WSW.	158
1892	Nov. 21	2.12 p. m.	49.10	ENE.	NW¼N.	101	....	....
1893	May 15	3 a. m.	46.17	SE¼E.	N.	124	....	....
1893	Sept. 1	3 p. m.	53.00	NNE.	SSW. *a*	180	WSW.	135
1893	Sept. 26	3.45 p. m.	50.22	NNE.	SW.	158	WSW.	135
1893	Sept. 30	4.11 p. m.	46.44	N¼NE.	SW.	146	W.	101
1894	Sept. 17	3 a. m.	42.31	N.	SSW.	158	SW.	135
1894	Sept. 28	1.36 a. m.	45.60	E¼NE.	NW¼N.	113	....	....
1894	Oct. 3	2.05 a. m.	48.02	NNE.	WSW.	135	....	....
1895	Sept. 3	2.55 p. m.	52.15	NNE.	SW.	158	W	113
1896	May 17	2.25 p. m.	51.10	N¼NW.	SW.	124	WSW.	101
1896	June 6	3 p. m.	51.65	SW.	E.	135	SE.	90
1896	July 22	3.40 a. m.	51.90	NE¼N.	SW.	169	....	....
1896	July 28	2.20 a. m.	50.59	NE¼N.	WSW.	146	....	....
1896	Aug. 8	4.50 a. m.	50.23	N.	SW¼W.	124	....	....
1896	Oct. 1	6.35 a. m.	50.35	N.	W¼SW.	101	W.	90
1896	Oct. 9	3.40 p. m.	51.10	NNE.	WSW.	135	W¼NW.	101
1897	Aug. 8	4.20 p. m.	52.55	NNE.	SSW.	180	SW¼W.	146
1897	Oct. 13	5 a. m.	51.86	S¼SW.	NNE.	169	E¼SE.	90
Mean...	....	....	....	....	....	144	....	109

a In this particular case we have taken the predominant wind in the course of an hour from the sheet of the anemograph.

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[1] We have omitted those cases in which two centers of depression have influenced Manila at the same time or other complications have been observed in the atmosphere difficult to explain.

GREATER OR LESS DEGREE OF CONVERGENCE FOR DIFFERENT WINDS. DEVIATION WHICH THESE MAY SUFFER IN CONSEQUENCE OF THE TOPOGRAPHICAL CONDITIONS OF EACH LOCALITY.

If we regard the average which this table gives us for the angle that the winds and the low clouds form with the bearing of the storm center, we shall see that it agrees pretty well with the law indicated by Father Viñes for these currents in the posterior part of the cyclone. But if we note with care each particular case, we shall without doubt find very different angles, very slight convergence being sometimes noted even with winds of the posterior part, and at other times, on the contrary, a maximum convergence. Therefore, this being so, it occurs to us to ask whether this same thing will happen in the whole archipelago, and what may be the cause of this diversity. This, we think, we can answer by saying that probably in each locality it will be noted after careful study that some winds are usually more or less convergent than others, the degree of convergence depending on the different topographical conditions. Hence it may very well be that the winds which are generally most convergent in Manila may be the least convergent in other points of the islands, and vice versa, which we could easily prove by studying the winds observed in other stations of Luzon at the time of the barometric minimas. But it would make this too long, and so we content ourselves by offering this suggestion, which is of the greatest importance, in order that we may not expect the same convergence of winds everywhere; for we see that this may be modified by the topographical conditions of each locality, and in order that we may understand that Father Viñes's laws of cyclonic circulation are more fully carried out on the high seas than on land, because there the winds can blow without meeting obstacles of any kind.

MOST CONVERGENT WINDS IN MANILA.

Now, then, which are the most and which the least convergent winds in Manila? For this, and only considering the cases included in Table CIX, we have taken separately the winds comprised between NNW. and NE., the NW. ¼ N. and W. ¼ NW., the W. and SSW., and the E. and SE., finding the mean of the angle corresponding to each one of these four groups. The result obtained is the following:

Winds.	No. of cases.	Mean of the angle formed by the direction of the wind and the bearing of the vortex.
		°
NE. to NNW	7	167
NW. ¼ N. to W. ¼ NW	4	118
W. to SSW	39	145
E. to SE	4	121

The greatest convergence at the time of the barometric minimum corresponds to the winds from the north quarter and the least to the winds from the east quarter. Please bear in mind that we say in the hour of the barometric minimum: for, generally speaking, a long experience teaches us that the most convergent winds are those of the third quarter, and therefore in this sense said proposition would be entirely false. But, limiting ourselves to the time of the minimum, it is very true, and we see it verified by innumerable facts, for we have seen that when a typhoon passes toward the S. and near Manila the winds blow from the N. and NNW. for the space of one or two days in such a fixed manner that they only incline toward the E. when the vortex is passing, or has already passed, the meridian of the capital, as if an obstacle, which may be the great mountain ranges of eastern Luzón, prevented the free circulation of the winds from the NE. and ENE. And in these cases it is seen that the weather vane having remained fixed in the N. or NNE. during so much time, still it veers toward the E. and ESE. and SE. afterwards in the course of very few hours, in these cases the convergence of these winds being generally very slight, notwithstanding that they belong to the posterior part of the cyclone. Therefore it appears that the valleys of the island deflect in Manila the cyclonic winds to the N. and NNW. before the typhoon passes toward the south, and to the E. and ESE. immediately after it has passed our meridian.

The convergence of the winds of the third quadrant, provided a cyclonic storm center is passing toward the NE. or N. of Manila, is generally very extraordinary, to the point of such winds being frequently wholly convergent, according to Table CIX. See what Father Algué writes about this in Chapter VII of the first part of the work Typhoons or Philippine Cyclones:

> Carefully examining the winds in Manila when a storm center is found in the first quarter, it is observed that these winds are the more convergent the greater the distance is from the cyclonic vortex, especially during the months of the third group and the two last of the second; so that the southwest winds blow much sooner than they should according to the laws of the 8, 10, 12, and even 14 quarter points. The inclination of the trajectory to the N. has a marked influence on the advancement of these winds.

PRECISE USE OF THE DIFFERENT ATMOSPHERIC CURRENTS AS PRECURSORY SIGNALS OF A TYPHOON.

From what we have said thus far we deduct that in order to be able to make accurate use of the different atmospheric currents as precursory signals of a typhoon we need, besides a perfect knowledge of the general circulation of the atmosphere in normal weather and of cyclonic circulation, also some knowledge, derived from experience, of the greater or lesser deviation which the winds and even the lowest clouds sometimes experience, according to the topographical conditions of each locality, unless the observer is on the high seas, for in that case it is evident that this last condition is not required.

The general circulation of the atmosphere in Manila has already been seen by our readers in Paragraph II of the preceding chapter. Therefore whenever the atmospheric currents are observed to be abnormal, and if, besides, comparing the direction of the winds with those of the low, high, and intermediate clouds, it is noted that they bear to each other the relation that the laws of cyclonic circulation, which we have just explained, demand, taking into account, especially for the winds, the local deviations which we have mentioned, one may be certain of the existence of a cyclone, and even approximately locate its bearing with respect to the observer.

The certainty of this result will be so much the greater as the number of the observations which have been taken of the diffe.ent classes of clouds is greater.

PRACTICAL EXAMPLES.

We shall close this paragraph with a few practical and instructive examples. We take two of them from the Meteorological Review of the month of November, 1891, also cited by Father Algué at the end of Chapter II of the second part of the work Typhoons or Philippine Cyclones.

TYPHOON OF NOVEMBER 12–14, 1891.

From the 12th to the 17th of November, 1891, two typhoons crossed the archipelago south of Luzon, which were the most disastrous of 1891 on account of both having traversed the rich provinces of the S. and SE. of the island. The first followed a trajectory from E. to W., directing itself toward Cochin China with great velocity. The second took the direction from ESE. to WNW., crossed the provinces S. of Manila, and ended in the Gulf of Tonquin. The first crossed the meridian of Manila the 13th, in the afternoon; the second the 16th, in the morning.

Now, let us study the movements of the cyclonic currents observed in Manila. The vortex of the first typhoon crossed 70 nautical miles from the capital, the second 50 miles. On the 10th day convergent cirrus clouds, veering toward the SE., began to be noticed, visible for a period of five hours. Convergence toward the S. was also noted. The southeastward veering continued on the 11th, when a tendency to fall was already observed in the barometer. It must be noted that on the 10th and 11th the vortex remained toward the ESE. of Manila, and at a distance of more than 600 miles at midday on the 11th, a mean velocity of 13 miles an hour being estimated for the meteor. At such a great distance it may well be that the rotation of the earth has an effect on the deviation of the cirrus clouds, because it was observed that during the 11th day the cirri came from the SSE. The 12th, the meteor being already nearer, they came from the SE. The 13th they were invisible, but the observer was aware that the typhoon was approaching from the second quarter. Well, then, the 11th, in the afternoon, the winds came from points comprised between N. and NE., the low clouds from ENE., and the cirrus from the SSE. On the afternoon of the 12th the cirri came constantly from the SE. and the cumulo-stratus clouds from the NE. At nightfall on the 12th the vortex must have been to the SE. $\frac{1}{4}$ E. of Manila; the deviation of the cirrus clouds was almost none. At 7 a. m. on the 13th more clouds began to be noticed below the common mass of nimbus, the course of which was rapid and the direction from NNE. Let us note the position of the currents at the time these broken-off clouds came from the NNE. The nimbus clouds, which were highest, moved from the NE., and the winds skimming the ground from the N. and even from the NNW.—a magnificent confirmation of the laws of cyclonic circulation. The winds and clouds were veering to the E. as the meteor advanced toward the S. of Manila, so that by the night of the 13th the winds already came from the N., NNE., and even

NE.; the low clouds from the ENE. By the morning of the 14th the clouds were already running from the ESE. and the winds remained stationary from the E. until noon.

TYPHOON OF THE 15TH TO 17TH OF NOVEMBER, 1891.

The irregularity in the directions of the currents on the afternoon of the 14th was not long in attracting attention. The low clouds and winds near the ground, instead of approaching the S., turned back and rather moved from the ESE. and from the E. at the time that the cirro-stratus clouds were also passing to the ESE., instead of indicating the position of the past storm, and at nightfall they made a well-defined convergence toward the S. The reason for these abnormalities was found in a new typhoon which, on the night of the 14th, was more than 500 miles from the capital, so that the directions observed in the currents were the resultants corresponding to the two cyclonic vortexes. On the 15th the currents became somewhat more normal. The upper clouds, while they could be seen, moved from the SE., in which course there was a cirrus arborization, as well as some convergent cirrus clouds. The cumulo-stratus and cumulo-nimbus throughout the day came from the ENE. On the arrival of the 16th day the cloudy and rainy state of the sky only permitted the movement of the clouds to be observed at 7 a. m., at which time some, the lowest, came from the N., and others, with great velocity, from the NE.; a little later they moved from the NE. and E., and the general mass of nimbus followed this last direction, the only one observed, when there did not appear at different heights loose clouds moving with great rapidity. When these appeared their courses were intermediate between those of the winds and those of the nimbus.

TYPHOONS OF OCTOBER 20, 1882, SEPTEMBER 30, 1893, AND OCTOBER 12-13, 1897.

In Plate LVI the convergence of the winds about the cyclonic vortex in three very severe typhoons, of sad remembrances for the archipelago, may be seen graphically. The first is the celebrated typhoon which burst over Manila the 20th of October, 1882. The two diagrams referring to this cyclone are taken from the notes which Father Faura wrote about it in the midst of that catastrophe. The other two are the most severe and terrible which have crossed these islands of late years; one burst on the northern region of Luzon the 30th of September, 1893; and the other on the Visayas Islands the 12th and 13th of October, 1897.

IX.—PHOTOGRAMETRY OF CLOUDS AND THE PREDICTION OF TYPHOONS.

IMPORTANCE OF THE SYSTEMATIC PHOTOGRAMETRY OF CLOUDS IN PREDICTING TYPHOONS.

In the previous chapter our readers have already seen the results obtained in this observatory, with the observations of the height, direction, and velocity of the clouds, made during fourteen consecutive months by means of photogrametric apparatus. These results are of so much more value and worth in proportion, as, by attentively examining the height and direction observed in the proximity of a cyclone and comparing them with the height and direction taken in normal weather, truly remarkable differences have been found, which have opened new avenues and increased the number of means which we have had at our disposal up to the present time for the prediction of typhoons in the Philippines.

This result, which is very practical and of very great utility, was not unexpected by us; but rather, we may assert, that the hope of obtaining it was what principally moved Father Frederico Faura, who was then director of this observatory, to accept the invitation which was extended to him by the international meteorological committee, under date of May 6, 1895, to cooperate in the task of combined observations of the clouds for a period of one year, and to order at once, for this purpose, the construction of the photogrameters which the observatory now has. And so, when said Father Faura answered the communication of Mr. Robert H. Scott, secretary of the international meteorological committee, he said that, in view of the supreme importance of the subject, he offered to take part in the international work of the observation of the clouds, and was disposed to order the construction of photographic apparatus for the observation and measurement of their heights and movements; which he did with all the more reason because, according to his judgment, said observations would pave the way to a deeper knowledge of the atmospheric changes peculiar to tropical regions.

PRACTICAL EXAMPLES WHICH PROVE THE RESULTS OBTAINED IN THIS SUBJECT.

There are various practical examples given by Father Algué in Chapter III of the second part of the work, Typhoons or Philippine Cyclones, and in part second, Chapter VII, of Clouds in the Philippine Archipelago, which go to prove—

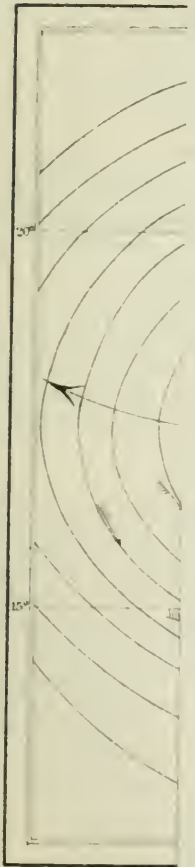
(1) That the photogrametric measurements of the clouds confirm the importance of the direction of the clouds in the prediction of the weather; (2) that the photogrametry of the clouds furnishes means by which the inclination of the axis of the storm may be known, and consequently to foresee toward which side the destructive force of the meteor will be greatest; and (3) that by means of the height and direction of the cirrus clouds the true and the false cirrus may be distinguished.

We shall only select here what refers to the typhoons of June 4 to 6, July 25 to 29, October 3 to 5 and 7 to 10, of the year 1896, the four trajectories of which may be seen included in the maps which we have given in Paragraph VI of this same chapter. Therefore let us see what Father Algué writes concerning these typhoons, carefully noting the three points which we have just indicated in the preceding lines.

TYPHOON OF JUNE 4 to 6, 1896.

The first typhoon felt in Manila, after the heights of the clouds began to be photographically measured, was that of June 6, which broke in southern Luzon, passing near Batangas, and going out to sea between Punta Santiago and Punta Restinga, after having caused more than twenty-five shipwrecks in the interinsular seas. This was one of

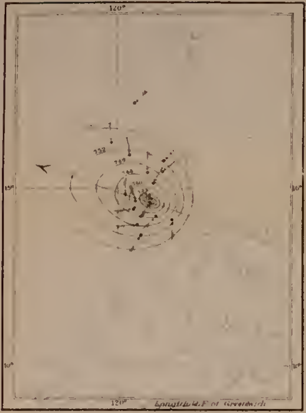
A TYPHOO



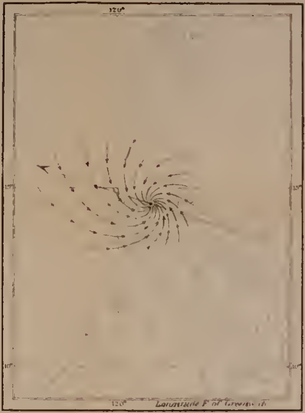
Trajectory
isobarometri

A TYPHOON OVER MANILA ON THE 20TH OF OCTOBER 1882

PLATE LVI

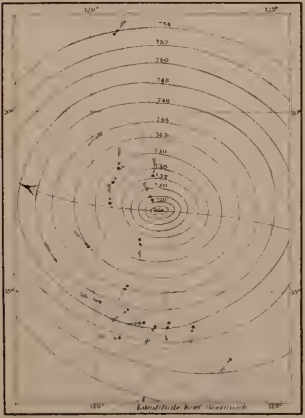


Trajectory of the storm and disposition of the isobarometric lines round the vortex



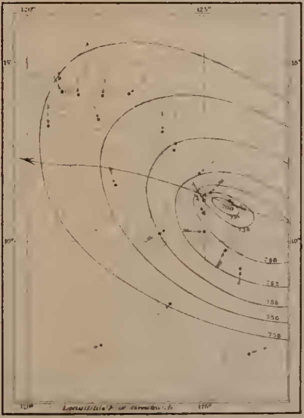
Convergence of the winds toward the centre of the storm

A TYPHOON OVER THE NORTH OF LUZON



Trajectory of the storm and disposition of the isobarometric lines at 4 P. M. 30th of September 1893

A TYPHOON OVER THE BISAYAN ISLANDS



Trajectory of the storm and disposition of the isobarometric lines at 10 A. M. 12th of October 1897 the most severe typhoons which crossed the archipelago during the year 1896. The fourth day the heights of the clouds were taken, and a group of symmetrical points corresponding to a cirrus was measured in the plates and two groups belonging to the cirro-stratus. The vortex was 500 nautical miles distant, and the barometers did not yet give any indication of the existence of the typhoon the third day, so much so that the observatory in the usual report to the press said: "Barometers rising in all the island." And although it is true that on the fourth day, at 10 a. m., there were some suspicions of atmospheric perturbation, still there was no sure intimation of it. The observatory reported: "Barometer high, but not fixed; weather uncertain." It was only on the fifth day that the probability of the presence of such a terrible typhoon was recognized, judging by the ordinary indications of the apparatus, whereas the photographic measurements of the fourth day discerned beyond doubt the cirrus which were emerging from the cyclonic vortex, and these measurements, at the same time that they gave the exact height of said cirrus and their direction, helped to determine the existence and bearing of the storm center.

June 4, 1896.

Class of cloud.	Hour.	Group.	Height above sea level.	X.	Y.	D.	Direction.	Velocity.
			Meters.	*Meters.*	*Meters.*	*Meters.*		
Cirrus	4.35 p. m.	First	12,300.8	−21,500.0	−16,418.1	27,051.3-3rd	SE.	Moderate.
Cirro-stratus	do	Second	11,027.4	26,401.1	−25,012.8	36,370.8-3rd	SE.	Do.
Do	do	Third	11,608.1	17,786.0	−26,385.9	31,820.7-3rd	SE.	Do.

The X and the Y are the rectangular coordinates of the projection of the mean point of the group, measured on the horizon.

The ordinal number expressed in column D indicates the quarter on which the mean point of the symmetrical points of which the group of the cloud consists is projected on the horizon. The number of meters in the same column expresses the horizontal distance of said projection from the southern station.[1]

It is to be noted that the same day, the 4th, a convergence of cirrus toward the E. was observed, so that on that day the storm center must have been toward the SE. of Manila, which, in view of the great distance from there, may have been due to the influence of the upper normal currents, which in June come from the ENE.

TYPHOON OF JULY 25–29, 1896.

In the month of July of the same year, 1896, besides the photographic measurements given in the preceding chapter, we find others very apropos to confirm what we are considering. Indeed, the 25th day groups of cirro-cumulus which were more than 8 kilometers high were measured—clouds which came from the ENE. and indicated, without doubt, the existence of a cyclonic vortex, which three days later crossed the NE. extremity of Luzon and was one of the most remarkable typhoons, on account of the extraordinary fall of the barometer, which in Aparri fell to 716 mm. As may be seen also in the attached table, on the 27th the cirrus masses came from the NNE., toward which quarter the vortex which passed at noon on the 28th near Aparri was located. The observatory reported on the 28th: "Very low barometers, but with a tendency to rise. The storm reached this island at daybreak by the province of Cagayán. It is of great intensity."

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[1] The same remarks are applicable to the following tables.

The strato-cumulus observed in the fourth quadrant came from the SSW., the 29th, when the vortex was to the NW. of Manila; which confirms what has already been said, that the winds as well as the clouds are convergent in the posterior part of the cyclone.

July, 1896.

Day.	Hour.	Class of clouds.	Group.	Height above sea level.	X.	Y.	D.	Direction.	Velocity.
				Meters.	*Meters.*	*Meters.*	*Meters.*		
25	11.29 a. m.	Cirro-cumulus.	First ..	8,587.5	23,436.8	12,521.1	26,568.8–1st.	ENE.	Moderate.
27	5.21 p. m.	.....do......	First ..	5,288.3	−7,410.5	3,359.0	8,136.4–2d.	NNE.	Do.
27	5.21 p. m.	.....do......	Second	5,021.5	−7,441.2	4,348.2	8,618.4–2d.	NNE.	Do.
29	9.30 a. m.	Strato-cumulus.	First ..	1,875.7	− 807.9	8,335.1	8,374.2–2d.	SSW.	Do.
29	9.30 a. m.	.....do......	Second	1,536.7	247.0	6,486.1	6,491.0–1st.	SSW.	Do.

This typhoon traversed the China Sea with great rapidity and entered the continent of Asia near Hongkong, where it caused so much destruction that, according to residents in that colony, such havoc had not been wrought since the celebrated typhoon of 1874.

TYPHOONS OF OCTOBER, 1896.

We find in the month of October, 1896, some cloud measurements that are very apt to confirm the great importance of the exact knowledge of the height and direction of the clouds in order to foretell and study atmospheric changes. We shall only examine a few in order to avoid prolixity.

On the 4th of October at daybreak a typical typhoon crossed the island of Luzon, which, entering toward the S. of Isabela, left by way of the China Sea S. of Vigan, cutting the province of Ilocos Sur almost in half. Now, then, on the 2d there were measured in Manila two groups of symmetrical points corresponding to the cirro-cumulus of this cyclone, which came from the NE. with moderate velocity, and a group corresponding to a high-cumulus, which also came from the NE., which indicated the existance of a cyclonic vortex toward the ENE. of Manila approximately. The barometers in Manila were rising, there being no other indications of the proximity of a cyclone than the measurements of those cirro-cumulus and high-cumulus clouds. On the 3d the barometers began to vary from early dawn, and the observatory taking into account the direction of the low clouds and of the intermediate clouds, reported the bearing of the cyclone in the following terms at 10 a. m. on the 3d: "Barometers again lowering; a depression toward the ENE. is marked in the Pacific; winds from the west quarters." We shall give the result of the photographic measurements in the following table. This typhoon entered the Celestial Empire at a point north of Hainán and not very far from this island.

When the above-mentioned typhoon passed through Luzón, on the fourth day of the month, another not less severe was following it in the

Pacific. The nebulosity also indicated the proximity of this new typhoon, because on the seventh day, in the morning, four groups of cirro-cumulus were measured, which were floating at a height much less than the average height of this class of clouds (for reasons which will soon be explained) and came from the ENE. with moderate velocity, which presupposed the existence of a cyclonic vortex toward the E. or ESE. The typhoon entered at the north of Casiguran (district of Principe) at considerable distance, and went out by the China Sea to the S. of Vigan. When the phenomenon left the archipelago the tenth day there was observed toward the NW. a remarkable convergence of cirrus formed by the posterior and more elevated currents of the cyclone. The height of these cirrus, as may be seen by the following table, was more than 15,000 meters.

October, 1896.

Day.	Hour.	Class of clouds.	Group.	Height above sea level, in meters.	X.	Y.	D.	Direction.	Velocity.
					Meters.	*Meters.*	*Meters.*		
2	9.55 a.m..	Ci.–Cu ...	First ..	6,349.1	−10,746.2	4.014.4	11,471.8–2d ..	NE.	Moderate.
2	.....do	Ci.–Cu ...	Second	5,260.1	−10,917.0	6,883.7	12,905.9–2d ..	NE.	Do.
2	.....do	A.–Cu ...	Fourth	3,804.8	−10,499.8	6,478.9	12,335.6–2d ..	NE.	Do.
7	8.42 a.m..	Ci.–Cu ...	First ..	4,817.9	— 546.6	9,266.0	9,283.0–2d ..	ENE.	Slight.
7	.....do	Ci.–Cu ...	Second	4,310.0	671.1	11,379.2	11,396.3–1st ..	ENE.	Do.
7	.....do	Ci.–Cu ...	Third.	3,325.6	— 816.1	12,459.6	12,488.0–2d ..	ENE.	Do.
7	.....do	Ci.–Cu ...	Fourth	3,333.3	— 470.2	16,587.5	16,594.2–2d ..	ENE.	Do.
10	11.37 a.m.	Ci	Unico.	15,338.4	2,959.2	33,651.9	33,783.8–1st..	N. ¼ NW.	Moderate.

This typhoon recurved in the China Sea toward the Straits of Formosa, as is learned from the observations from the French battle ship *Isly*, which on the 10th was navigating between Formosa and the NE. coast of Luzon, with her course toward Manila.

INCLINATION OF THE AXIS OF THE STORM KNOWN BY MEANS OF THE PHOTOGRAMETRIC OBSERVATIONS.

Having seen the importance of the photogrametric observations of the clouds in foretelling the existence and position of the cyclone, let us proceed to investigate another point of even more importance, which is the relation of the height compared with the class itself of clouds in a typhoon, in order to predict or know toward what quarter of the cyclone the violence of the inferior currents or winds will be greatest, on which the destructive force of the meteor depends. Having ascertained the mean height of each class of clouds in a certain station a noticeable increase or diminution with respect to said mean height will suggest the direction of the inclination of the axis, even without a comparison of the heights, one observation being sufficient for it. Hence, it follows that, as the severity of the typhoon depends in a great measure on the inclination of the axis, because the winds in the direction toward which the axis is inclined will be very near the ground, and, consequently, very violent, and, on the contrary, the higher winds and clouds will move on the opposite side, it may well be asserted that from the height of the nebulousness it may be determined toward which quarter the lower currents will be most violent. We shall verify this reasoning by a few practical facts.

PRACTICAL EXAMPLES.

We have said of the typhoon which passed by Aparri the 28th of July, 1896, that on crossing near that station, and, consequently, through the interior of Luzon, the axis was inclined toward the posterior part of the cyclone. Let us see how the measurement of the cyclonic clouds confirms that hypothesis. In fact, on the 25th the cirro-cumulus of the typhoon were measured and were found to be almost 8,600 meters high. This height of the cirro-cumulus indicated the inclination of the axis toward the opposite side, which was confirmed by the measurements of the 27th, according to which the cirro-cumulus were more than 3 kilometers lower and proceeded from a different side of the typhoon. See the table corresponding to July, 1896.

We find another remarkable example in the photogrametric measurements of the 7th and 10th of October, 1896. In treating of the photogrametric observations of October 7, 1896, we said that the cirro-cumulus observed were running low; without doubt, the reason was that at that time the axis was inclined away from the archipelago, remaining so inclined the time that the vortex was in the Pacific up to the 9th day; because, examined with care, we find that the anterior winds were the strongest in the most eastern of the northern stations, such as Aparri and Tuguegarao. Notwithstanding, when the vortex was in the interior of the island the inclination of the axis was considerably changed, judging from the violence of the winds in Vigan and Bolinao. Photogrametric observations could not be made while the vortex remained within the island on account of the bad state of the sky and continual squalls. On the 10th the cirrus were measured at more than 15 kilometers of altitude, an elevation much greater than the normal one, which supposes an inclination of the axis toward the anterior quadrants, similar to the inclination which the storm had in the Pacific. The winds observed in Vigan on the morning of the 10th confirm this hypothesis, because of being very violent and hurricanelike in the early morning; at 10 a. m. they had become much less violent, the barometer being still very low, so that at the hour of the observation in Manila, 11.37 a. m., the winds were not blowing so near the ground in Vigan and consequently the axis was inclined toward the anterior quadrants of the typhoon.

NOTICE.

In conclusion, we state that, according to the extent of the whole body of the typhoon, the influence of the inclination of the axis on the inferior currents is little noticed toward the extremes, and gradually increases in the neighborhood of the vortex, as experience teaches. Besided, in view of the nature and structure of the typhoon, it does not appear that the variation of the inclination of the axis, or nutation can be rapid, but slow and gradual, in passing from the sea to the land, or crossing land and mountains, according to the greater or lesser resistance of the obstacles.

DISTINCTION BETWEEN THE FALSE AND TRUE CIRRUS BY MEANS OF THE PHOTOGRAMETRY OF THE CLOUDS.

It remains for us to occupy ourselves with another point of no less importance than the previous ones; it is to investigate whether the measurements of the height of the nebulousness could be an efficacious means of distinguishing the true cirrus clouds from the false.

We are not unaware that it is impossible to deduct from this investigation any practical rule for mariners, as it is impossible to measure, with accuracy, the height of the clouds from shipboard, for which reason neither can the deductions from the other two points which we have treated in this chapter be useful to them in practice, in which our only purpose was to offer new methods of foretelling atmospheric changes from fixed observatories, and which count on instruments and a plant apropos for the photogrametric observations of the clouds, and so increase the stock of means to announce and give warning in due time of the dangers for the benefit of those who navigate.

Navigators may attend to the following indications to distinguish the true from the false cirrus in cases of the convergence of cirrus.

1. If it is noted that the convergent cirrus are supported on masses of cumulo-nimbus, they are evidently false.

2. Given that it is not seen that the converging cirrus belong to masses of cumulo-nimbus, if it is observed that the convergence is very persistent the cirrus are true, with little movement of transference.

3. If the convergence does not continue, it can not be concluded that they are false; but in this case some resources are still left to the navigator: (*a*) If the nucleus of convergent cirrus moves with rapidity, it may be concluded that the cirrus are false; (*b*) if said nucleus follows the direction of the cumulo-nimbus, although the movement may not be rapid, it will be probable that the cirrus are also false; and finally, if the convergence does not continue till the cirrus clouds disappear, the sun being very high, as sometimes happens, no definite opinion can be formed. If they reappear almost in the same position at sundown the cirrus are true. If the convergence disappears on account of the interposition of other clouds, no definite opinion can be formed either, and the observer should await their reappearance.

4. When the same convergence from distant points is noticed, it may be taken as produced by true cirrus clouds. This means is more limited, and is only at the disposal of central observatories where telegraphic advises from various stations are collected.

And, returning to the principal point of this investigation, the result is that, according to the measurements taken of false cirrus during the period of photogrametric observation—that is to say, from June 1, 1896, to July 31, 1897—as a general rule the false cirrus have been found to be lower than the true to such a degree that, the mean height of the true cirrus being some 11 kilometers, that of the false does not exceed 7 kilometers, a height corresponding to the intermediate clouds. Hence it is inferred that, in case of doubt regarding the nature of the cirrus, it may generally be concluded that they are true if they are found at a height greater than 11 kilometers. It is noted that the months in which the false cirrus are highest are May, July, and November. We are speaking in a general way, because if in any of these months the necessity or advisability should arise of distinguishing the cirrus, aside from the height, it would be necessary to make use of the preceding indications in order to decide the matter accurately.

We have observed another circumstance which may serve to settle any doubt regarding the nature of the cirrus, and it is the direction of the movement, because if the movement is ascending and the height not great it is very probable that the cirrus may be false. From 23 photogrametric observations of false cirrus which we have studied we noted a descending movement of the cirrus in only 3.

From what has been said it is concluded that the height as well as the direction of the cirrus may contribute toward solving any doubt regarding the truth or falsity of the same.

X.—MOVEMENTS OF THE BAROMETER DURING TYPHOONS—APPARATUS INVENTED BY FATHERS FAURA AND ALGUÉ FOR THE PREDICTION OF TYPHOONS IN THE PHILIPPINES AND IN THE FAR EAST.

PRACTICAL RULES GIVEN BY FATHER FAURA FOR THE PRECISE USE OF BAROMETRIC MOVEMENTS AS A PRECURSORY SIGN OF A STORM.

As we have already stated in Chapter II, in intertropical regions the annual and daily course of atmospheric pressure is very regular so long as none of these terrible meteors or cyclones present themselves, which alter with their presence laws which are so fixed and invariable. And naturally, as the value of the precursory signal of a typhoon based on the barometric movements must be so much the greater as the regularity of these same movements in normal weather is greater, it is seen that assiduous observation of this valuable instrument will be, in the Tropics more than anywhere else, a most efficacious means for the prediction of typhoons or cyclones.

So Father Faura understood it when, after many years of experience, he laid down in Precursory Storm Signals the following practical rule: "The weather begins to be doubtful from the moment in which any of the laws to which the barometer is subject in normal weather is violated."

And the same father, some years later, condensed into this another rule as valuable or more so than the preceding one he had already written in Precursory Storm Signals, to predict, by means of the barometor only, the greater or lesser intensity of a typhoon: "The intensity of a typhoon depends on the amplitude of the deviation outside of the exact limits of the diurnal and nocturnal oscillations."

NECESSITY OF BEARING WELL IN MIND THE LAWS OF THE DAILY OSCILLATION OF THE BAROMETER.

It may be observed that all that can be said about the movements of the barometer in order that they may be utilized as a precursory sign of storm has been condensed into these two practical rules of Father Faura. From them the importance and necessity of bearing well in mind the laws of the daily oscillation of atmospheric pressure not only in general, but even in particular, for the different months of the year, is deducted, for it is only by doing this that we can know when any alteration of these laws takes place, and the greater or lesser degree of said alteration.

So that, keeping in view what we said on this subject in Paragraph V of Chapter II, we think that it will not be superfluous to indicate, with the greatest possible brevity, the principal cases which may be considered as included under each one of these two rules of Father Faura.

A. CASES IN WHICH THE WEATHER MAY BE REGARDED AS VERY SUSPICIOUS AND WHEN THE EXISTENCE OF A TYPHOON MAY EVEN BE ASSURED.

The weather may be regarded as very suspicious, and even the existence of an atmospheric pertuebation, which is in some way approaching the locality, may be assured—

1. When the amplitude of the night descent is similar to that of the afternoon descent, so that the dawn minimum becomes equal to or still lower than the minimum of the previous afternoon.

2. When the barometer rises less in the nocturnal semioscillation than in the diurnal.

3. When the ascent of the diurnal semioscillation barely amounts to 1 millimeter.

4. When the amplitude of the diurnal descent exceeds 3.5 mm. in the months from June to September, both inclusive; or of 4 mm. in the months of May, October, November, and December; or of 4.5 mm. in January, February, March, and April. Note, however, that this rule supposes further that the barometer is at its normal height or not far from it; because, if it is already somewhat low, then it may be taken as a general rule for all the months that there is an indication of a distant typhoon when the amount of the diurnal descent is greater than 3 mm. or 3.5 mm.

These three indications only serve to convince us of the existence of a storm which is approaching us in some way, but not to indicate whether it will pass near or far, or if it will burst with violence in the locality. For this, the following rules help us:

B. CASES IN WHICH IT MAY BE ASSURED THAT THE TYPHOON WILL BURST WITH VIOLENCE IN THE LOCALITY.

It may be assured that the storm will pass near by and burst with violence in the locality—

1. When the barometer remains stationary without rising any, or scarcely any, during the hours of ascent.

2. This case is more alarming than the preceding when the barometer, after the tropical hours of the morning or afternoon minimum, still continues to fall in the hours of ascent.

3. When the barometer in the hours of descent falls at the rate of more than 1 millimeter per hour.

THE APPROBATION WHICH FATHER FAURA'S BAROMETER AND FATHER ALGUÉ'S BAROCYCLONOMETER HAVE RECEIVED FROM MARINERS.

From these slight indications, which we do not amplify for fear of making this too lengthy, we get an idea of how much may be gained from the observations of the barometer only in the prediction of typhoons. One most evident proof of it we have in the extraordinary approbation which Father Faura's well-known and popular barometer, applied to the prediction of the weather in the Philippine Archipelago, had from the very beginning, and which was offered to the public by its inventor in 1886; and that which the recent barocyclonometer of Father Algué, an improvement on Father Faura's barometer, and intended for the prediction of typhoons not only in the Philippine Archipelago, but in the whole of the Far East, has just had.

We have thought that it would please our readers to reproduce here the description and the rules which Father Faura gave in a brief and concise pamphlet entitled The Aneroid Barometer Applied to the Prediction of the Weather in the Archipelago of the Philippines for the use of his barometer; and this with so much the more reason, because the edition published of it is to-day wholly exhausted. The reproduction in Spanish of another English pamphlet similar to the preceding, in which Father Algué describes and gives simple rules for the use of his barocyclonometer, will not be of less interest.

The mere reading of these two most interesting documents will serve to confirm more and more the supreme importance of barometric movements as precursory signs of a typhoon, especially if combined with the signs given by the atmospheric currents.

THE ANEROID BAROMETER APPLIED TO THE PREDICTION OF THE WEATHER IN THE PHILIPPINE ARCHIPELAGO.

OBJECT AND PURPOSE OF THIS INSTRUMENT.

Moved by a desire to make known in the archipelago the utility of the indications of the barometer, I published a few years ago The Precursory Signs of Storm, the product of a careful and prolonged study of the diverse fluctuations which this instrument undergoes during the numerous and varied changes of atmospheric pressure, according to the divers kinds of tempests which are experienced in this locality. In that work I tried to be as clear and concise as possible, and I think that I partially attained my object, which was to bring it within the reach of all minds. But I must also confess that, in order to apply those rules with accuracy, frequently greater attention is required than is many times compatible with the serious and peremptory obligations which weigh on the navigator and on private persons who have valuable interests exposed to the fury of these terrible phenomena. For this same reason, even at that time, I conceived the idea of engraving those laws, although very much summarized, on the barometers themselves most frequently used and most handy for observation, in order that a mere glance at the instrument would give the signal "Alert" and would put them on guard against any atmospheric change of any importance that might threaten them. However, I refrained for some time, because of the fear that such indications might be disregarded, as are those which artists are wont to engrave on the barometers offered to the trade with the words "Fair weather," "Rain," "Storm," etc., and which have with reason been criticised by meteorologists because they do not conform to the laws which govern the movements of the atmosphere and by the public in general, who rarely find any agreement between the phenomena which develop and the indications of the instrument. Therefore I wished to verify it first by myself by using barometers whose movements were very regular and which responded well to all the changes of pressure. The result was what I had expected, and it could not fail to be so, since the foundation on which I was supported was the same that had served me to write The Precursory Signs of Storm, already sufficiently verified by the personal experience of various illustrious mariners who had used them on different occasions. In view of this I believed that my work in behalf of the public should not be longer delayed, so that they could utilize the advantages which, to my mind, they have over the old barometers used in the archipelago up to the present time. In offering it I should state also that the new indications are only applicable within the archipelago and in the immediate neighborhood of its coasts, because the empirical study which was made of the fluctuations the barometer undergoes in the different classes of storms which are experienced here and which induced me to modify the barometer to the new form in which I present it only extends to them. Outside of the archipelago it has

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[1] The first twelve models from Germany were soon disposed of, and the orders received in this observatory, not only from the Philippines, but from the coast of China and Japan, are many; and from the admirals of the fleet and commandants of men-of-war and the captains of merchant steamers which navigate these seas.

no more utility than that of any other ordinary barometer. The form I have given to the new instruments is seen represented in the attached Plate LVII.

As is seen, I have substituted the titles of the old barometers with those of north winds, variable weather, typhoon rather distant, etc., because they are more in conformity with the phenomena which are usually experienced here, and which nomenclature is used and known by everybody, even the natives. But I did not do this without first carrying out an empirical study, very long and laborious certainly, of the movements which the needle of the aneroid barometer may have, deducted from the movements which the mercury of the Förtin barometer suffers, according to the season of the year and the kind of perturbations which make it vary.

NOTICES.

This presupposes—First. That said aneroid barometers have been carefully made, so that the movements of the needle may mark with equal or approximate exactitude to those of mercury.

Second. That they should be corrected before using, by comparing them with a good mercurial barometer free from instrumental error and corrected for the constant error of capillarity and for the variations of temperature and sea level. In Manila and the neighboring provinces the correction can be made by comparing the aneroids with the barometer of the observatory or with the observations which are published daily in the newspapers of the capital, and in the other provinces with the barometers of the nearest secondary stations, which are exactly like the Manila barometer, and whose corrected observations the respective observers will furnish.

Third. This comparison should be made after the instrument has been installed in the point where it is to operate. I give this notice because if the barometer is compared before being set up in its place and is then taken to the interior of the islands it may happen that it may be located in a point which is higher above the sea level than the point where it was compared, and in that case the indications placed around the barometer would lose all their value. These indications are calculated for when the heights given by the instrument are reduced to the level of the sea, and therefore it has been so stated in the note placed at the foot of the barometer itself. Now, then, the mercury of the barometer and the needle of the aneroid lower when they are removed from the indicated level, and are higher in the air. The amount of the descent is here on an average 1 millimeter in the mercurial barometer and one division in the aneroid for each 11 meters of elevation. Therefore if, for example, it happens that at the sea level the needle indicates 759, if the aneroid is transferred to a point which is 55 meters above said level it would indicate at the same hour 754. The first division is the superior limit of variable weather, and is generally a sign of good weather, and the second division is already within the indication of a typhoon somewhat distant; therefore, at the height of 55 meters the position of the needle would be alarming if said height is not taken into account, whereas at the sea level or near it it would be a sign of safety. If use is to be made of the barometer on sea trips, or if it is to be placed at a point that is not higher than 10 meters above sea level, then there is no necessity of taking this precaution, because in that case the level is little changed, and so long as the altitude does not exceed 9 to 10 meters the indications placed around the barometer answer the purpose for which they are intended.

Fourth. It would be useful if the comparison of which I have just spoken were made frequently, once a year for example, and whenever the needle has undergone a great oscillation in consequence of a severe storm.

The reason is that, as the instrument is made of very delicate pieces of metal of different density, the changes of temperature continued for a long time, as well as violent oscillations, may somewhat alter the tension of the pieces, and for this reason cause the needle to give erroneous indications.

Fifth. Finally, before making the observation, it is advisable to give a few light raps with the finger on the crystal, in order to overcome the lethargy of the spring which supports the needle and force it to place itself in its true position.

If these remarks are borne in mind I am sure that the indications substituted for the old ones will be of great utility, and I take the liberty of asserting that no great storm will be able to surprise us without having been foreseen, allowing time to protect ourselves against its most terrible effects. Of course, it will be impossible to estimate beforehand all the severity it will develop in the locality, but we will know, first, its existence, and, second, the danger we run of being attacked by it, for the position which the needle will take successively will tell us both things, aided by the explanations corresponding to each one of the printed titles about the face of the barometer. But as storms, although all have something essential in which they resemble each other, yet differ much in their accidental characteristics, and in many cases these might lead to error, sometimes inspiring baseless fears, and in others, when there is real danger, failing to inspire them, it will not be superfluous to somewhat amplify the readings corresponding to each one of the titles, so that in all cases they may contribute to an easy and profitable interpretation. However, I shall not go beyond a purely practical amplification, leaving for later on the exposition of the theory which, if our Lord God grants me the power to bringing to a happy issue, I shall have published in due course.

First reading.—North winds: Rains on the eastern coast of the archipelago. Good weather generally on the western.

The needle usually oscillates between 759 and 767 from October to April, the oscillation being most marked in the hours of its daily maximum. In the hours of the minimum, which is observed between 3 and 4 in the afternoon, and 3 and 4 of the dawn, it may exceed the limit of 759 and enter into the division of variable weather, this last being likely to take place especially in the months of October, March, and April, with less frequency in November and February, and rarely in December and January.

While the needle remains within said limit, namely, between 759 and 767, there is no danger of a typhoon near, the weather to be expected in this case is that indicated in the note of the barometer; on the eastern coast of the archipelago the winds will blow generally from the north, or rather between the N. and E., which will increase in strength as the needle rises; these winds will sometimes be stormy on that coast, especially when the needle approaches the upper limit 767, and more so if it passes beyond that limit, which seldom occurs, and to a very slight degree in the months of December and January. The rains, without being constant, will still be frequent, constituting properly the rainy season on that coast. On the western coast fair weather generally prevails and the winds have not the force they display on the eastern coast; however, sometimes the rains will reach it, which will take place when the precipitation on the eastern coast is prolonged and abundant, for in that case the clouds carried away by the winds of the first quadrant usually cross the island without having deposited all the water which the condensation of the vapors had formed on the other coast.

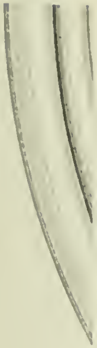
If the needle goes beyond 759 in any of the said months at the hours of the maximum, attention must be given to the movements it may have successively and to the prevailing winds. But the explanation of this case corresponds to the reading of variable weather.

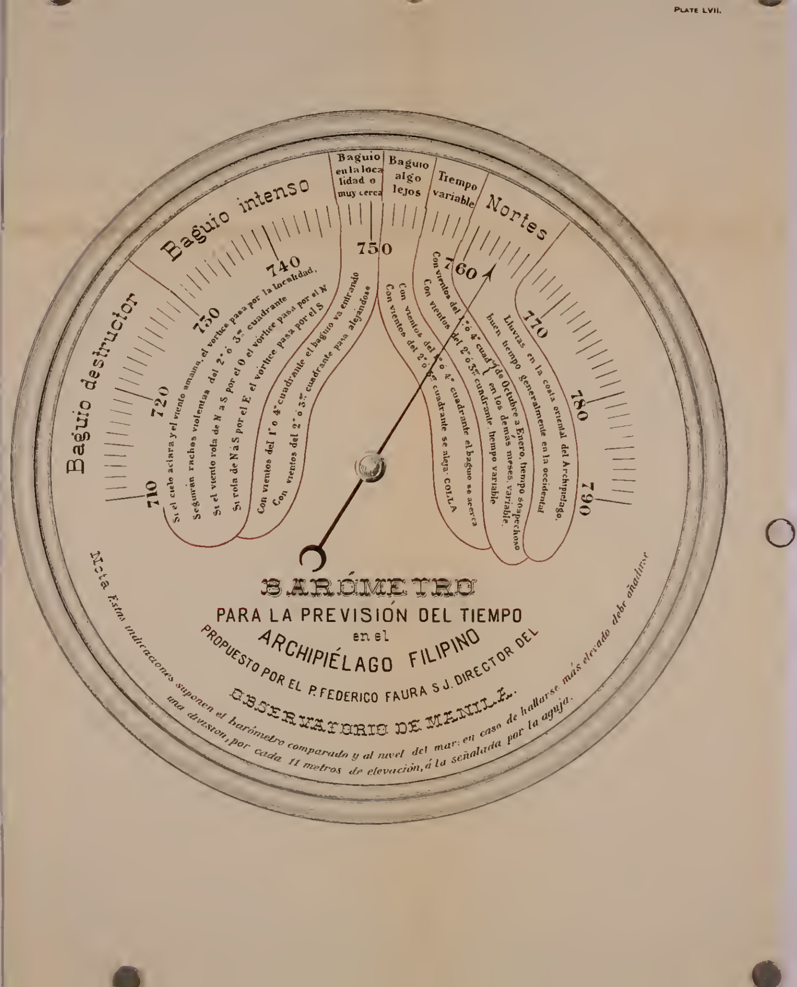
Second reading.—Variable weather: With winds from the first or fourth quarter from October to January, suspicious weather; in the other months variable weather. With winds from the second or third quarter, variable weather.

Before enlarging on the reading corresponding to variable weather it will not be out of place to state that we call winds of the first quadrant (quarter) those comprised between N. and E., of the second those included between E. and S., of the third those comprised between S. and W., and finally winds of the fourth those comprised between W. and N.

This being established, the needle usually places itself in the division marked "Variable weather" from May to September, inclusive, the lower limit of its oscillation being more exact in the hours of its daily minimum—that is, between 3 and 4 in the afternoon and 3 and 4 in the morning. In the hours of its maximum it may rise to the division "North winds," but it never rises as much as in the months when these winds usually prevail, and if at any time it rises a great deal and passes this limit of various divisions, reaching the height of 763 and 764, this is usually a sign that within a few days there will be a change, generally a cyclonic storm or typhoon, although it can not be concluded from this that it will break out in the locality. For this it will be necessary to await the movements which the needle presents when the storm approaches and depend upon what these may indicate afterwards.

I have said that if in the months from October to April, at the hours of its daily maximum, the needle passes out of the division 759 and enters into "Variable weather," attention should be paid to the successive movements the needle may have and to the prevailing winds; because in these months going out of said division is always the effect of a typhoon, which is still distant, but which may pass through the locality. In order to ascertain this, see if the needle continues falling slowly and if the winds remain fixed between N. and W. or between N. and E. If this takes place, it is certain that the storm is approaching the locality. In proof of this, it will be seen that at 4 in the afternoon or in the morning, which are the hours when the barometer should begin to rise, it will remain stationary or continue falling, the squalls will begin to be repeated, and the gusts of wind will be more frequent and stronger. Notwithstanding, the typhoon will not be severe except in case the needle should pass




Baguio destructor
Baguio intenso
Baguio en la localidad o muy cerca
Baguio algo lejos
Tiempo variable
Nortes
710
720
730
740
750
760
770
780
790
Si el cielo aclara y el viento amaina, el vórtice pasa por la localidad.
Seguirán rachas violentas del 2° ó 3.er cuadrante
Si el viento rola de N á S por el O el vórtice pasa por el N
Si rola de N á S por el E el vórtice pasa por el S
Con vientos del 1° ó 4° cuadrante el baguio va entrando
Con vientos del 2° ó 3.er cuadrante pasa alejándose
Con vientos del 1° ó 4° cuadrante el baguio se acerca
Con vientos del 2° ó 3.er cuadrante se aleja: COLLA
Con vientos del 1° ó 4° cuad.te de Octubre á Enero, tiempo sospechoso
en los demás meses, variable.
Con vientos del 2° ó 3.er cuadrante, tiempo variable
Lluvias en la costa oriental del Archipiélago.
buen tiempo generalmente en la occidental
BARÓMETRO
PARA LA PREVISIÓN DEL TIEMPO
en el
ARCHIPIÉLAGO FILIPINO
PROPUESTO POR EL P. FEDERICO FAURA S J. DIRECTOR DEL
OBSERVATORIO DE MANILA.
Nota. Estas indicaciones suponen el barómetro comparado y al nivel del mar; en caso de hallarse más elevado debe añadirse una división, por cada 11 metros de elevación, á la señalada por la aguja.

out of the division "Typhoon somewhat distant" and enter that of "Typhoon in the locality or very near," the winds remaining in the first or fourth quarter. If, before the needle enters the space "Typhoon in the locality," the winds should change to the second or third quarter, then the typhoon is passing to the N. or to the S.—to the N. if the winds change by the W. to the third quarter; to the S. if they change to the second quarter, veering by the E. From the time this change takes place the needle will cease to fall and the ascent will soon begin, indicating that the typhoon is departing.

If the needle does not go outside of this division during said months—that is to say, from May to September, both inclusive—then there is not the slighest danger of a storm; the only thing which may be expected in this case is that there may be local whirlwinds, but passing, which have no more importance than that they bring with them the generation of electricity, which usually accompanies them, or that the showers continue for some time and winds from the third quarter, if the needle had previously indicated "Typhoon somewhat distant."

Third reading.—Typhoon somewhat distant: With winds from the first or fourth quarter the typhoon is approaching. With winds from the second or third quarter, it is going away—"colla."

The needle does not enter on this space except in consequence of a cyclonic storm or typhoon which is still distant. In the months of April and May, at the hours of the minimum of the afternoon—that is to say, from 2 to 5—it sometimes passes the limit 755 without the above being verified; but this rarely happens, to a small degree, and on days when the heat has been excessive; in the other months, and even in April and May outside of the hours cited, it is always the effect of a typhoon which is at some distance.

The needle having entered the division "Typhoon somewhat distant," it may be known whether the storm is approaching by the persistence or variability with which the winds blow from the first or fourth quarter, while the needle continues to fall, and on the more or less rapid descent of the same. In general, it may be said that if the needle reaches 751, the lower limit of "Typhoon somewhat distant," without the winds having ceased to blow from the first or fourth quarter, although they may have been light, the storm will be severe and the winds will acquire the force of what is commonly understood here as a typhoon; but if, while the needle is moving between 755 and 751, the winds are blowing now from the second and now from the third quarter, although they may afterwards change again to the first or to the fourth, then the storm will not exceed the severity which the storms commonly called "collas" usually develop.

The two preceding cases can be readily distinguished by the way in which each presents itself; in the first case the needle during the rising hours—that is to say, from 4 to 10 in the morning, or from 4 to 10 at night—will remain stationary or will fall a little; then from 10 to 4 in the afternoon, or from 10 to 4 at dawn, it will fall considerably; the sky from the beginning will be covered with a milky white veil, quite opaque, and toward the E. it will be completely closed; toward the W. it will be clearer, making a marked contrast with the E.; from time to time the dense clouds which appear heaped up toward the E. will extend almost over the entire sky and will let fall light showers, known by the name of fine drizzle; the winds will continue between N. and W., or between N. and E., refreshing at times and squally; at intervals the sky will again become clear of clouds, but the dense white veil of which we have spoken always remaining, called in meteorology the cirrus veil, which will occasion the formation of solar or lunar halos; these phenomena will go on reproducing themselves successively at intervals, which will be shorter as the needle goes on falling, and with ever increasing intensity, so that what were at first light showers are soon converted into squalls of wind and rain, which will be at last continued and violent, the needle continuing to fall, while the winds do not change to the second or third quarter. When these have reached the WSW. and sometimes the SW. or the ESE., if the wind veers by the E. the needle will cease falling and the ascent will soon commence. From this moment you may be sure that the storm is passing away; but it can not be said that the force of the wind will immediately diminish, because this depends on circumstances which it is irrelevant to refer to here. In general it will not increase, and it is likely to be the same for some time if the winds which have prevailed while the needle was falling were light, or it will soon diminish if the first winds were strong. In all cases the storm will end with winds comprised between the SE. and SW.

The second case is more complex than the first, and may be reduced to three principal classes of storms:

1. That present themselves in the beginning as the preceding case, with almost the same appearance of the sky, but the barometer falling less in the hours of descent, and rising some, although little, in those of ascent. The winds will be light and sta-

tionary in the fourth or in the first quarter until, when the barometer reaches 753 or 752, the wind jumps to the SW. and a long and continued squall of wind and rain begins. The ascent of the barometer will soon begin again, all finishing thus in the course of a single day or in a few hours. This case is the effect of a storm which is passing to the E. and the N. successively, and at some distance.

2. That the barometer begins to fall without the sky being very much changed, and with little stability in the winds, which, although in general they will be from the first or fourth quarter, will sometimes jump to the second or third. The first day the barometer will fall little and the oscillation in the hours of ascent and descent will be somewhat altered, but will not be wholly different. The second day it will fall more, and so on, successively, so that the minimum of each day will be less than that of the previous day. When the barometer reaches its minimum descent, and sometimes after the ascent has already begun, the heavy showers and wind from the SW. will begin, interrupted by lulls of some hours, and so it will continue for several days until the barometer is already quite high. This case is the result of cyclonic centers which are located sometimes to the NNW. or to the N. of the archipelago from June to September, inclusive, remaining sometimes stationary for a long time and without the movement of transference which characterizes other centers of this sort. The intensity and duration of this kind of storms depend on the distance at which said cyclonic centers are located, and on the class of depression which causes them, and on the producing causes of this depression. In these cases the barometer alone, by its ascent, fixity, or descent, will indicate whether the storm is increasing, if it will remain the same, or if it is going to disappear, but it will not tell definitely when it is going to stop.

3. Finally, the third class of storms of this kind that may be observed here is due, not to a single depression, but to a system of depressions which frequently take place in the same months cited and which pass to the E. and N. of Luzon at intervals of two, three, or four days from one another. The first of these depressions presents itself like that of the first case; there follows an interruption of one, two, or three days and then another depression returns, and so on successively; the barometer lowers a little in each one of these and also rises a little in the intervals in which the winds usually return to the first or fourth quarter, being light whenever they are in these points and squally and usually accompanied by rain when they jump to the third quarter. The duration of these storms depends on the number and form of the depressions from which they originate. These three kinds of storms, which I have just described, constitute what are usually called here "Collas."

Fourth reading.—Typhoon near or in the locality: With winds from the first or fourth quarter, the typhoon is coming; with winds from the second or third quarter, it is passing and leaving.

If the needle enters this division and the winds continue blowing from the first or fourth quarter, you may be sure that the storm will burst with violence; if, on the contrary, the winds have already changed to the WSW., or to the ESE., when the needle falls below the upper limit of 751, then the storm will be relatively light.

Fifth and sixth readings.—Severe and destructive typhoon: If the sky clears and the wind abates, the vortex is passing through the locality; violent gusts from the first and third quarters, will continue; if the wind veers from N. to S. by the W., the vortex is passing to the N.; if the wind turns from N. to S. by the E., the vortex is passing toward the S.

If the needle enters in the first of these divisions, the typhoon is always severe, and it will be more so if it enters when the winds continue blowing from the first or fourth quarter. In case the vortex passes through the locality, a clearness will be noticed toward the E., which will slowly extend until it reaches the zenith of the observer. The winds will greatly diminish in violence, and possibly will calm down altogether, a singular contrast being noted between the strength of the previous wind and the relative or absolute calm experienced while the vortex is passing. The storm in this case is not yet finished. All this time the barometer will remain at its lowest point. When the vortex has passed, it will begin to rise, and the winds will again blow with violence, whose intensity and duration will generally be in an inverse ratio to that which the winds had in the anterior part of the storm, so that the more violent and prolonged these may have been the less those will be, and, on the contrary, the intensity and duration of the winds succeeding the storm will be the greater, as that of the preceding may have been less, relatively speaking.

The length of time which the calm of the vortex may last is variable, but it always allows a few moments of truce to prepare to receive the winds which are to come from the second or third quarter. * * *

OBJECT FATHER ALGUÉ HAD IN MIND ON INVENTING HIS BAROCYCLONOMETER.

Up to this point we have described Father Faura's barometer, the indications of which are restricted, as its inventor himself says, to the limited zone of our archipelago. Father Algué, desiring to perfect such a valuable instrument, advanced one more step, and conceived the idea of making it useful and applicable to all the extreme Orient, as will be seen in the description of the barocyclonometer, which we reproduce here with the greatest pleasure. But first our readers will permit us to say a few words regarding the principal reasons which induced Father Algué to offer this new apparatus to the public. He himself explains them in the prologue to the little Spanish work, The Barocyclonometer, in the following terms:

> Two reasons mainly induced me to procure the construction of the new apparatus which is described in this little book. The first was considering the great convenience, not to say necessity, of a barometer which could be used indiscriminately in all the latitudes of the Far East, now that the exigencies of traffic and commerce on the one hand, and the manifold considerations of an international character on the other, open each day new courses to the frequent navigation of our mariners of the Navy as well as of the merchant ships. And as it is true in these seas the meteorological elements present such different characteristics that it sometimes happens that the navigator in a single voyage finds normal barometric heights as diverse as 754 mm. and 758 mm. in the short distance which separates Hongkong from Manila, and 771 mm. and 759 mm. between Chefoo and Iloilo, it is quite impossible in these cases to apply the fixed readings which are commonly engraved on the faces of barometers, even the best of them, as are those of the popular barometer of Father Faura, which is only applicable to the limited zone of our archipelago. Add to this that in the seas of this Far East the barometric height limit of the extreme zone of the typhoons, a datum of capital importance, fluctuates between very different values, such as 765 mm. for the parallels 25°–32° north latitude, and 756 mm. for the parallels 10°–16° north latitude during the winter months. For which reason it is impossible for the mariner to be able to navigate securely and anticipate the danger of such terrible meteors by using a "common reading" in seas where the extreme barometric heights of the body of the cyclone differ normally more than 8 mm. How this difficulty has been obviated in the aneroid the reader will see in the course of this work.
>
> The other reason, of no less weight, is, having observed with sorrow, that the popularization of Father Faura's barometer has given rise to some manufacturing firms imitating said aneroids in such a way, in order to meet with profit industrial competition, that frequently the observer, instead of finding in them an accurate and trustworthy instrument, as would be right, finds himself with a hardware toy capable of discrediting the good arrangement of the indications and reading on the face, if its fame were not so justly established. Several times we have seen Father Faura lament this pernicious abuse, which, unfortunately, has no remedy. For this reason, now that the advisability of offering a new apparatus to the public is recognized which, on account of being universal, may be used also in other latitudes than those of our archipelago, we shall from the very beginning make sure of the most important point, which is the fidelity of the instrument, so that persons who wish to have the quality of their barometer guaranteed can have it.[1]

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[1] The construction of this instrument was entrusted to the house of the maker, G. Lufft, of Stuttgart. The barometer and the cyclonometer are constructed separately, in order that those who use Father Faura's barometer, which is so popular in this archipelago, may complete it without so much expense by simply getting the cyclonometer.

> The two above reasons refer exclusively to the aneroid of the new apparatus. Touching the cyclonometer, there is no reason to enlarge on the practical usefulness which the mariner may derive from it, principally in his voyages on the high seas. Whoever reads this pamphlet may judge for himself of it. We only claim to offer him one as a guide, simplifying the apparatus so that he can manage it even in cases when the manifold attentions to diverse maneuvers and the anxiety and confusion which usually accompany the imminence of danger do not give an opportunity for complicated calculations.

Up to this point, quoting Father Algué, it may be added to-day that the first reason given by him is now so much stronger, for with the recent annexation of these islands by the United States navigation on the seas to the N. and E. of Luzon has been very greatly increased, and consequently an instrument which to the merit of Father Faura's barometer adds the incomparable advantage of being applicable with the greatest facility to different latitudes throughout the Far East, must be very highly appreciated by mariners.

But let us look at the description and use of this new apparatus. We take it from the pamphlet The Barocyclonometer:

THE BAROCYCLONOMETER—DESCRIPTION OF THE INSTRUMENT.

The barocyclonometer is no more than an aneroid barometer combined with a cyclonometer.

BAROMETER.

The barometer, which, according to intelligent persons, is most carefully made and one of the best aneroids which have been imported into the Philippines, was made with the intention that it could be universally used throughout the Far East and that its scale could be used for the latitudes comprehended between 0° and 50° north latitude and for heights from 0 to 900 feet.

To this end the divisions are engraved on an annular disk of silver-plated metal, which is subdived into three different sections. The first indicates the monsoons and normal weather; the second, variable weather; and the third, which is the most important of all, serves to indicate the relation which exists between the atmospheric pressure and the diverse zones of a typhoon.

A special study has been made to find the value of the mean pressure in the exterior limit of the typhoon in different latitudes and in the different months of the year. The introduction of the movable annular disk in the barometer is based on the result of this study.[1]

We regard the entire area of a typhoon as divided into four zones, which we specify with the letters A, B, C, and D, the zone A being the outermost.

CYCLONOMETER.

The cyclonometer represents graphically a horizontal section of the lowest surface of the typhoon. It is divided into four concentric zones which correspond to the four divisions, A, B, C, and D, of the movable disk of the barometer. The directions of the inferior currents around the vortex in each one of these zones are represented by small arrows, and that of the vortex by a larger arrow. The circles which divide the zones, as well as the arrows, are engraved on a disk of silver-plated metal, which is movable about its center and is inclosed in a case covered with a crystal. Over this crystal there are two long needles. One of them is graduated from the center to two-thirds of its

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[1] Making use of the table which we give later on, the instrument may be used for north latitudes comprised between 0° and 50°, although the indications of some barometers do not reach more than 25° north latitude.

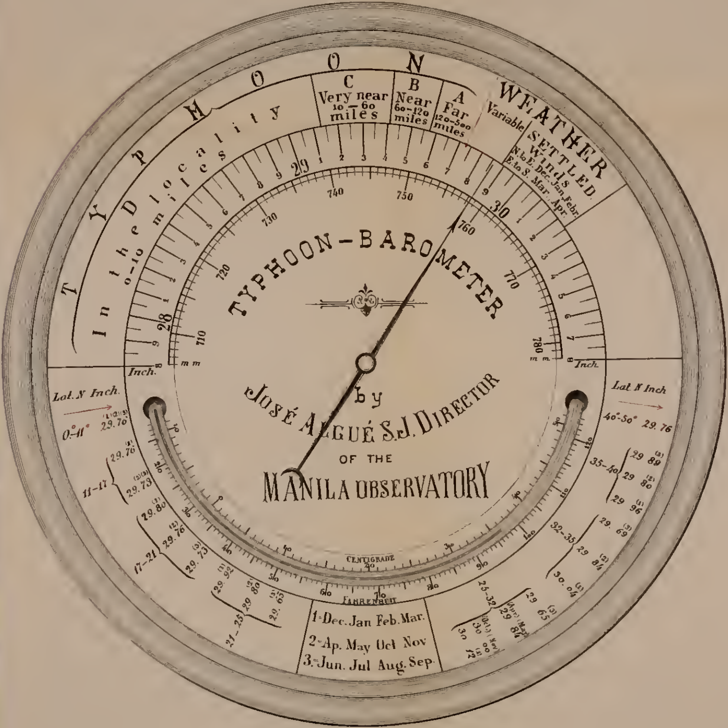
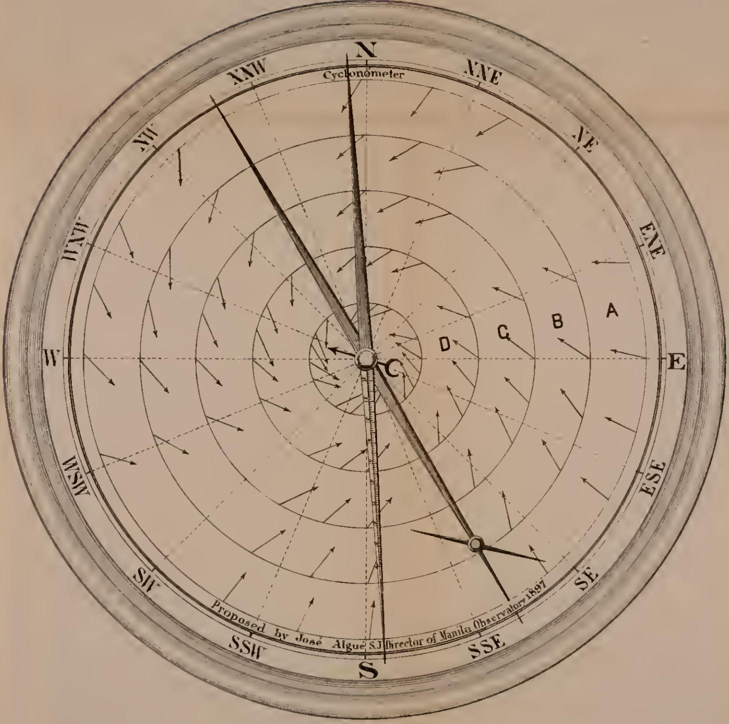

TYPHOON
WEATHER
In the locality
In the miles
0–10
C
Very near
10–60
miles
B
Near
60–120
miles
A
Far
120–500
miles
Variable
SETTLED
Winds
N. to E. Dec. Jan. Febr.
E. to S. Mar. Apr.
28
29
30
710
720
730
740
750
760
770
780
mm
Inch.
TYPHOON-BAROMETER
by
JOSÉ ALGUÉ S.J. DIRECTOR
OF THE
MANILA OBSERVATORY
Lat. N Inch
0°–11°
29.70
11–17
29.76
29.73
17–21
29.80
29.76
29.73
21–25
29.92
29.80
29.69
Lat. N Inch
40°–50°
29.76
35–40
29.89
29.80
29.96
32–35
29.69
29.84
30.04
25–32
29.65
29.84
30.00
30.12
CENTIGRADE
FAHRENHEIT
1-Dec. Jan Feb. Mar.
2-Ap. May Oct Nov
3-Jun. Jul Aug. Sep.

PLATE LVIII 818.


N
NNW
Cyclonometer
NNE
NW
NE
WNW
ENE
A
B
C
D
W
E
C
WSW
ESE
SW
SE
Proposed by José Algué S.J. Director of Manila Observatory 1897
SSW
SSE
S

semilength into one hundred equal parts, and the other has at two-thirds of its semilength a somewhat smaller needle, which is movable about its center. Both long needles are placed so that their center coincides with that of the disk and they may also be moved around it by means of a small button. Their length is equal to the diameter of the outer zone A of the typhoon.

USE AND MANAGEMENT OF THE INSTRUMENT.

The barometer, in conjunction with the cyclonometer, can give a probable solution of the following problems:

1. What is the atmospheric pressure in the neighborhood of a typhoon, at its outer limit, as well as at different distances from the vortex?
2. How can the existence of a typhoon be known?
3. How can the position of the vortex be known?
4. How can the probable distance of the vortex be found?
5. How can the direction of the vortex at any given moment be calculated?

WHAT IS THE ATMOSPHERIC PRESSURE IN THE NEIGHBORHOOD OF A TYPHOON, AT ITS OUTER LIMIT, AS WELL AS AT DIFFERENT DISTANCES FROM THE VORTEX?

The pressure at the outer limit of a typhoon varies according to the latitude and according to the atmospheric conditions which change in the course of the year. This is the reason why we divide the months of the year into three groups—because the conditions of the typhoons in the months corresponding to each one of these groups are very similar.

As the fruit of a comparative study, based on long experience, of the atmospheric pressure in the neighborhood of the outer limit of typhoons and the normal pressure during the year in various latitudes, we present the following table:

Barometric heights at the outer limit of Zone A of a typhoon in the Northern Hemisphere.

Between parallels—	Height.	Rainfall.	Period.
	Mm.	*Inches.*	
0°-11° N	756	29.76	Throughout the year.
11°-17°	756	29.76	During the months of first group.
	755	29.73	During the months of second and third groups.
17°-21°	757	29.80	During the months of first group.
	756	29.76	During the months of second group.
	755	29.73	During the months of third group.
21°-25°	760	29.92	During the months of first group.
	757	29.80	During the months of second group.
	753	29.65	During the months of third group.
25°-32°	765	30.12	During the months of first group.
	762	30.00	During the months of October and November.
	758	29.84	During the months of April and May.
	753	29.65	During the months of third group.
32°-35°	763	30.04	During the months of first group.
	758	29.84	During the months of second group.
	754	29.69	During the months of third group.
35°-40°	761	29.96	During the months of first group.
	757	29.80	During the months of second group.
	754	29.69	During the months of third group.
40°-50°	756	29.76	Throughout the year.

On account of the marked influence which the relative positions of the seas and the continents exercise on the normal atmospheric pressure, the following restrictions should be introduced in the values of the preceding table:

From Sumatra to the Caroline Islands, or from 95° to 150° E. of Greenwich.
From the Gulf of Siam to the Ladrone Islands, or from 100° to 145° E. of Greenwich.
From Tonquin to the Ladrone Islands, or from 105° to 145° E. of Greenwich.
From the Continent of Asia to 150° E. of Greenwich.

A mere inspection of the preceding table will fully prove the need mariners have for our barometer.

The small red arrow on the annular movable disk should be placed so as to indicate the pressure given in the preceding table, and then all the other divisions will indicate the weather according to the parallel in which the observer finds himself.

The pressure on entering Zone A is 4 mm. (0.16 inch) higher than the limit of Zone B, and on entering this the pressure is also 4 mm. (0.16 inch) higher than that of Zone C. This Zone embraces 7 mm. (0.28 inch).

The distance of Zone A from the vortex of the typhoon varies from 120 to 150 miles; that of Zone B from 60 to 120. The maximum distance of Zone C is 60 miles and the minimum some 10 miles. Zone D is already in the vortex or very near it.

EXISTENCE OF THE TYPHOON.

The indications of the barometer having been accommodated to the parallel of the observer by the placing of the little red arrow, as we have just said, as soon as the needle of the barometer enters Zone A it is probable that the observer is at some point in Zone A of the typhoon; and if besides there is noted in the barometer a tendency to fall the observer may be sure that it is, indeed, from the influence of a typhoon.

POSITION OF THE VORTEX.

To find the position of the vortex the observer should place himself in the plane of the cyclonometer, according to the height of the barometer and the direction of the wind or low clouds; this he will find represented by some of the small arrows engraved on the disk. This done, he will soon see where the vortex is on the plane of the cyclonometer. For this purpose he may also make use of 1 of the long needles of the cyclonometer, placing it so that one of its extremes coincides with the intersection of the small arrow, which indicates the direction of the wind then prevailing, and the circumference which divides one zone from another; the opposite end of said long needle will indicate the position of the center, on the card, of the winds engraved around the cyclonometer.

DISTANCE OF THE VORTEX.

The probable distance from the center is given on the face of the barometer itself.

Zone A has 4 divisions, as we have said before; the barometer passes through it with a very slow descent. The distance has been estimated to be from 120 to 150 miles.

The descent of the barometer in Zone B is a little more marked, and the estimated distance is from 60 to 120 miles.

In Zones C and D the barometric descent is rapid, and the distance from the vortex is less than 60 miles.

Each one of these details is scientifically proven in the above-mentioned pamphlet.

MOVEMENT AND DIRECTION OF THE VORTEX.

When once the observer has placed himself in any of the zones of the cyclonometer he may, by making use of the two needles, ascertain the movement and direction of the vortex by carrying out the following instructions:

Place the central arrow engraved on the disk according to the average trajectory which the typhoons follow in the latitude and month in which the observer is,[1] moving the disk for this purpose. If the barometer continues falling and the observer sees, for example, that it is entering Zone C, then he should place the double needle so that the end opposite the one on which it has the small needle coincides with the intersection of the small arrow which indicates the prevailing wind and the circumference which divides Zone C from B; the other end will give him the position of the vortex, as has been said before. If the barometer still continues falling, and the winds increase in force and blow in the same direction, the vortex is approaching the place of the observer, and in the direction indicated by the needle. If while the barometer is falling the wind veers, the observer (leaving the double needle in position) should place the other graduated needle so that the end which has no graduation coincides with the intersection of the small arrow which indicates the new direction of the wind and the circumference of Zone C. When the barometer lowers in the rising hours its reading should not be corrected, but if it falls in the descending hours then the value corresponding to the oscillation should be added, in order to ascertain the real descent of the barometer.

If the wind changes rapidly in direction the operation of finding the position of the vortex should be frequently repeated, but otherwise it will be sufficient to repeat it every twelve hours, without applying any correction to the barometer.

The graduated end of the needle should be toward the course by which the vortex has passed or is passing. For example, if the vortex has passed or is passing to the south of the observer the graduated end of the needle should be at some point between east, south, and west of the compass card, as in the second example. Afterwards, by comparing the two barometric readings corresponding to the directions of the wind which have been taken, the probable trajectory which the typhoon is following will easily be found. For this, let A be the height of the barometer at the outer limit of the typhoon, which is given in the preceding table; A′ the height of the barometer when the double needle was moved; A″ the last reading of the barometer; D′[2]

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[1] The mean trajectory of typhoons in each one of the twelve months of the year was published in the above-mentioned pamphlet, page 58.

[2] D′ has an arbitrary value which we represent by 100 (number of divisions of the graduated needle), and X will be the number of these divisions.

the distance of the observer from the vortex when the barometer had the height A′; and D″ the distance of the vortex at height A″ of the barometer. Applying the formula of Fournier we shall have:

$$\frac{A-A'}{A-A''}=\frac{D'}{D''}$$

PRACTICAL EXAMPLES.

A practical example will make this operation clearer. During the typhoon of the 24th to the 25th of October, 1898, we had in Manila, at 3 p. m. on the 24th, winds from the SW.¼ W., and at the same time the height of the barometer was 752.35 mm. Taking the double needle and making its end coincide with the small arrow which marks the direction of the wind, we shall find that the position of the vortex was NE.¼ E. In the early morning hours of the following day, 3 a. m., the wind blew from the SSW., and the height of the barometer was 751.90 mm. Now, moving the graduated needle we shall find that the new position of the vortex was almost N.¼ NE. Applying these data to the above formula we shall have:

$$\frac{755-751.90}{755-752.35}=\frac{100}{X}\text{; hence } X=85.$$

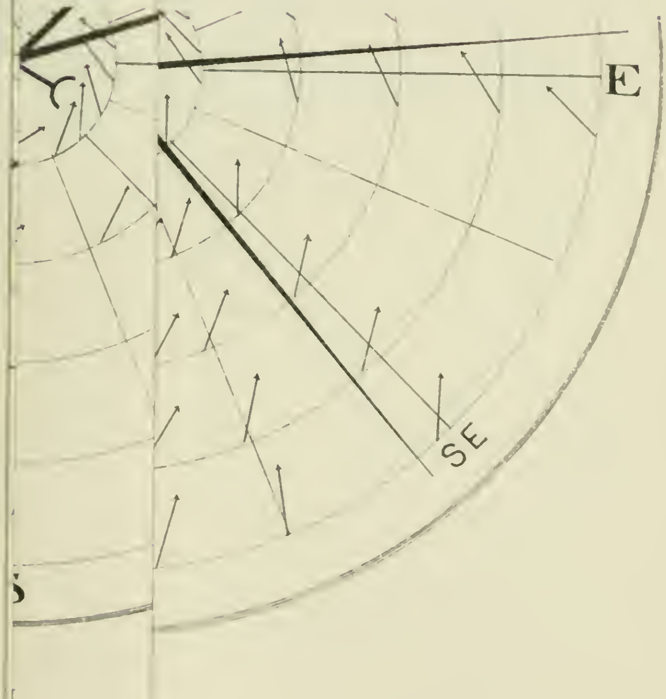
If, leaving the two long needles in position, we place the end of the small needle so that it points to the division 85, the direction of this will give us the probable trajectory which the vortex followed during the time which intervened between 3 p. m. of the 24th and 3 a. m. of the 25th, namely, from E. ¼ SE. to W. ¼ NW.

In Plate LIX we give diagrams of four typhoons whose course was well known to us.

BAROGRAPHIC AND ANEMOGRAPHIC CURVES TRACED BY THE SPRUNG-FUESS BAROGRAPH AND THE BEKLEY ANEMOGRAPH IN THE TYPHOONS OF NOVEMBER 9–10, 1890, AND NOVEMBER 15–16, 1891.

Let us conclude the subject of this paragraph and of the preceding by a facsimile of the curves traced in this observatory by the Sprung-Fuess barograph and the Bekley anemograph during the passage of two typhoons of November 9–10, 1890, and November 15–16, 1891 (Pl. LX). And in order that in both the relation of the movements of the barometer and the direction and force of the wind with the different positions of the vortex may be clearly seen, we have added to the same a plate of the trajectory followed by the storm in crossing the island of Luzon. Besides, as both typhoons crossed at some distance from Manila, and therefore the curves of our barograph can not be given as a model of the movements which atmospheric pressure suffers in the vortex itself or very near it, we have completed our work with the reproduction of the curve traced by a Richard barograph in the meteorological station of Albay when the typhoon of November 15, 1891, passed very near there and to the south.

We have chosen these two typhoons, which passed, respectively, to the N. and S. of Manila, in order that there may be seen on the sheets of the anemograph the different veering of the winds observed in both cases; that is to say, from the N. to the S. by the W. in the first and from the N. to the S. by the E. in the second case.



[

EMBER 16-17 HOON [1]

ILA Nueva Ecija)

m., Lowest cl 49.76 mm., wind SE. } Zone B.
" " 48.00 " " S. }

755—746.85 -748.00 100
——— ——— = ——; x = 75
755—749.84 -749.76 x

enter moving figure, to NE. by N. See the track of this

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os ó tifones de el Gravina" por el P. José Algué S. J., published by

USE OF THE BAROCYCLONOMETER. PRACTICAL CASES.

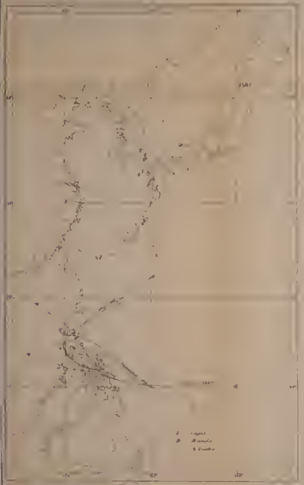
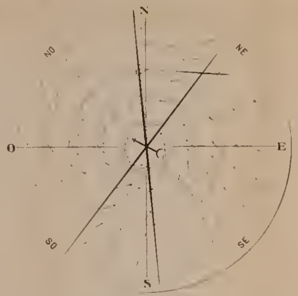


Figure I



I

SAMAR AND LEYTE TYPHOON

[illegible] (Samar Island)

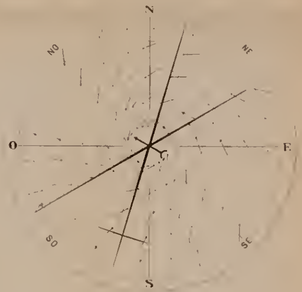
[illegible] 1897 [illegible] p. m. Barometer [illegible] mm. wind W [illegible] } Zone D

According to the formula [illegible]

Position of the needles as in the 1st figure. Hence direction of center to W [illegible] the track of this typhoon in the map.

[illegible]

Figure II



II

SAMAR AND LEYTE TYPHOON

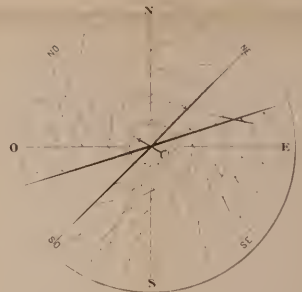
Manila

October 12th, 1897 [illegible] Barometer 752.38 mm. wind NE } Zone A

According to the formula [illegible]

Figure 2nd shows the position of the needles. Consequently the center moved to WNW.

Figure III



III

TYPHOON OF SEPTEMBER [illegible]

Manila

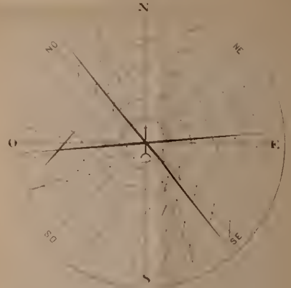
[illegible] p. m. Barometer [illegible] mm. Lower clouds WNW } Zone [illegible]

According to the formula [illegible]

Positions of the needles as in 3rd figure. Center moving to [illegible] the track of the typhoon in the map.

This typhoon has been discussed in the work [illegible]

Figure IV



IV

[illegible]

XI.—THE METEOROLOGIC SERVICE OF THE CENTRAL OBSERVATORY OF MANILA.

We close this compendious study which we have just made upon the cyclones of the extreme Orient with a brief indication of the meteorological service of this observatory and the signs which are hoisted in Manila in the time of typhoons.

THE METEOROLOGICAL SERVICE IN THE PHILIPPINES BEFORE THE 1ST OF MAY, 1898.

In the Engraving LXI it can be seen of what character the meteorological service was which was used by the central observatory of Manila to announce the typhoons before the 1st of May, 1898, from which announcements were sent to the coasts of China and Japan, and are yet sent in the same way.

OFFICIAL SEISMICAL METEOROLOGICAL STATIONS OF THE SECOND CLASS.

Since 1884 there have been 14 official seismical meteorological stations distributed over the whole island of Luzon, to which, later on, there were added 4 in Visayas when, in 1897, a cable was laid to unite these islands with the archipelago.

In the following outline we give the name and geographic location of each one of these stations:

Island.	Station.	North latitude.		Longitude east from Greenwich.	
		°	′	°	′
Cebu	Inburan	9	41	123	19
Do	Cebu	10	18	123	51
Panay	Iloilo	10	12	122	35
Do	Capiz	11	36	122	42
Luzon	Albay	13	9	123	42
Do	Nueva Caceres	13	38	123	17
Do	Punta Santiago	13	46	120	39
Do	Inyabas	14	1	121	34
Do	Aimonan	14	2	121	51
Do	Daet	14	4	122	56
Do	Punta Restinga	14	16	120	37
Do	San Isidro	15	22	120	53
Do	Cabo Bolinao	16	23	119	46
Do	Bayombong	16	29	121	12
Do	Vigan	17	34	120	26
Do	Inguegorao	17	35	121	39
Do	Laoag	18	13	120	34
Do	Aparri	18	22	121	34

NO OFFICIAL SEISMICAL METEOROLOGICAL STATIONS OF THE THIRD CLASS.

Besides these seismical meteorological stations there were many others, not official, and which were not united by telegraph with Manila, but were distributed principally in Visayas and Mindanao, and even in the Carolines and Marianas, which, with their daily observations, remitted monthly to this observatory, were of great service in the study of the hurricanes or Philippine cyclones.

The names of these stations, which we may call third class, and their geographic positions are as follows:

Island.	Station.	North latitude.		East longitude from Greenwich.	
		°	'	°	'
Jolo	Jolo	6	03	120	59
Mindanao	Mati	6	56	126	14
Ponapé	Oriental Carolines	6	46	158	23
Mindanao	Zamboanga	6	54	122	03
Do	Davao	7	05	125	35
Do	Cottabato	7	16	124	12
Do	Pollok	7	26	124	12
Do	Dapitan	8	40	123	23
Do	Fanday	9	02	126	10
Yap (Oriental Carolines)	Yap	9	29	138	05
Mindanao	Surigao	9	47	125	29
Negros	La Carlota (model farm)	10	24	123	05
Calamianes	Cuyo	10	51	121	00
Samar	Calbáyog	12	06	124	38
Mindoro	Mambúrao	13	16	120	32
Marianas, or Ladrones	San Luiz de Apra (Guam)	13	28	144	44
Do	Agana (Guam)	13	30	144	45
Luzon	Magalang (agronomical station)	15	14	120	48
Do	Isabela (agronomical station)	17	10	121	41

STATIONS OF COCHIN CHINA AND THE COASTS OF CHINA AND JAPAN WHICH HAVE SENT DAILY METEOROLOGICAL OBSERVATIONS TO THE OBSERVATORY OF MANILA.

The stations of Cochin China and on the coasts of China and Japan which have sent us, twice a day, their meteorological observations are the following:

Stations.	North latitude.		East longitude from Greenwich.	
	°	'	°	'
Cape St. James (Cochin China)	10	20	107	05
Haiphong (Tonkin)	20	52	106	40
South Cape (Formosa)	21	55	120	51
Hongkong (China)	22	18	114	10
Auping (Formosa)	22	59	120	13
Isigakijina (Liukiu)	24	20	124	07
Amoy (China)	24	28	118	05
Foochow (China)	26	08	119	38
Naha (Liukiu)	26	13	127	41
Oshima (Linchoten)	28	23	129	30
Shanghai (China)	31	14	121	29
Kagoshima (Japan)	31	35	130	33
Nagasaki (Japan)	32	44	129	52
Kochi (Japan)	33	33	133	32
Tokyo (Japan)	35	41	139	45

The announcements of typhoons from the observatory of Manila have been sent, and are yet being sent, to the following capitals: Hongkong, Tokyo, Shanghai, Haiphong, Saigon, and Macao.

PROJECT OF A NEW METEOROLOGICAL SERVICE IN THE PHILIPPINES PRESENTED BY THE OBSERVATORY OF MANILA TO THE GOVERNMENT OF THE UNITED STATES.

This was the meteorological service which was used in the central observatory of Manila prior to the events which took place the 1st of May, 1898, in the Philippines.

From this date naturally the service was interrupted as far as the stations of the archipelago were concerned, but not in those stations of Cochin China and on the coasts of China and Japan.

Father José Algué, the director of the observatory, with the expectation that it will not be long before cable communication is extended, not only to the principal islands of the archipelago, but also to the Carolines and Marianas, has presented to the Government of the United States a new plan for meteorological service depending from the central observatory of Manila, as we have indicated in the Engraving XLII.

According to this project the archipelago will be divided into four meteorological districts, two in the northern part and the other two in the central region. The meteorological stations have been divided into four categories, depending partly on the importance of towns and partly also upon their geographic position. These four groups of stations, with the name of each one and its position, may be seen in the following tables:

FIRST-CLASS STATIONS.

Station.	North latitude.		East longitude from Greenwich.	
	°	′	°	′
Zamboanga	06	51	122	03
Cebu	10	18	123	54
Bacolod	10	11	122	56
Iloilo	10	42	122	35
Tacloban	11	15	124	59
Albay	13	09	123	42
Daet	14	01	122	56
Cabo Bolinao	16	29	119	46
Aparri	18	22	121	34

SECOND-CLASS STATIONS.

Station.	North latitude.		East longitude from Greenwich.	
	°	′	°	′
Joló	6	03	120	59
Isabela de Basilan	6	43	121	57
Cabo Melville	7	50	117	00
Puerto Princesa	8	48	117	49
Dumaguete	9	19	123	17
Yap	9	29	138	05
Fagbilaran	9	38	123	53
Surigao	9	47	125	29
Cuyo	10	51	121	00
Capiz	11	36	122	42
Borongan	11	11	125	23
Catbalogan	11	48	124	54
Mamburas	13	16	120	32
Fabaco	13	21	123	43
Agaña (Guam-Marianas)	13	30	144	15
Punta Santiago	13	46	120	39
Fayabas	14	01	121	34
Altimonan	14	02	121	51
Punta Restinga ó Mariveles ó Corregidor	14	16	120	37
San Isidro	15	22	120	53
Casiguran	16	02	122	01
Bayombong	16	37	121	12
Vigan	17	34	120	20
Fuguegarao	17	35	121	39
Laoag	18	13	120	34
Cabo Bojeador	18	30	120	33
Cabo Engaño	18	35	122	06
Santo Domingo	20	29	121	59

THIRD-CLASS STATIONS.

Station.	North latitude.		East longitude from Greenwich.	
	°	′	°	′
Mati	6	56	126	14
Dávao	7	01	125	35
Caraga	7	15	126	30
Butúan	8	55	124	31
Fándag	9	02	126	12
Fuburan	9	44	123	19
Dinágat	9	58	125	31
San José de Buenavista	10	45	121	55
Ormoc	11	00	124	31
Concepción	11	17	123	05
Palanoc	12	21	123	35
Romblón	12	36	122	16
Sorsogón	12	59	123	58
San Pascual	13	08	122	58
Calapan	13	24	121	10
Santa Cruz	13	29	122	03

PLUVIOMETRIC OR RAIN-MEASURING STATIONS.

	°	′	°	′
Baganga	7	29	126	29
Bislig	8	13	126	17
Cagayán	8	26	124	42
Falacogon	8	33	125	48
Fagoloan	8	33	124	40
Lianga	8	35	126	11
Falisayan	9	00	124	51
Cantilan	9	20	125	57
Gigáquit	9	32	125	44
Calbáyog	12	06	124	38
Batangas	13	45	121	03
Libmanan	13	46	123	06
Ragay	13	48	122	46
Guinayangan	13	52	122	27
Calamba	14	12	121	10
Santa Cruz (Laguna)	14	18	121	24
Cavite	14	29	120	55
Morong	14	31	121	15
Balanga	14	41	120	35
Montalbán	14	45	120	09
Olongapó	14	49	120	15
Bulacán	14	50	120	52
Bacolor	15	01	120	37
San Fernando (Pampanga)	15	02	120	40
Yba	15	21	119	57
Cabanatúan	15	29	120	56
Tárlac	15	31	120	35
Carranglán	16	01	121	02
Lingayen	16	02	120	13
Dagupan	16	04	120	25
San Fernando (Unión)	16	37	120	19
Cárig	16	40	121	38
Flagan	17	10	121	41
Candón	17	12	120	26
Binorugan	17	33	121	02
Bangued	17	28	120	32
Alcalá	17	53	121	35

In the same project of Father Algué, he designates the instruments which all these stations would have to be provided with in the following form, concerning the category of the same:

INSTRUMENTS FOR FIRST-CLASS STATIONS.

Magistral barometer of mercury (Negretti and Zambra).
Barocyclonometer, or barometer of typhoons.
Barograph (Richard type).
Psicrograph (Richard type).
Thermometer (Fuess type).
Thermometer (Fuess type), maximum and minimum.
Psicrometer (Fuess type).
Cases for thermometers (Fuess type).
Thermometer for terrestrial radiation (Negretti and Zambra.)
Anemograph (Denza type).
Heliograph (Jordan type).

Vaporameter of Piche.
Pluviometer (Negretti and Zambra).
Nefoscope of Cecchi.
Seismograph of Cecchi.

INSTRUMENTS FOR THE SECOND-CLASS STATIONS.

Magistral barometer of mercury (Fortin type).
Barocyclonometer, or barometer of typhoons.
Barograph.
Cases for thermometers.
Thermometers (Fuess type).
Thermometers (Fuess type), maximum and minimum.
Psicrometer.
Heliograph.
Vaporameter of Piche).
Nefoscope of Cecchi.
Pluviometers (Negretti and Zambra).
Anemometer.
Anemoscope.
Seismograph.

INSTRUMENTS FOR THE THIRD-CLASS STATIONS.

Barocyclonometer, or barometer of typhoons.
Thermometer of maximums and minimums.
Thermometers for dry and wet.
Cases for thermometers.
Pluviometer.
Anemoscope (Anemometer of Wilds).
Seismograph (common type).

STATIONS AT DIFFERENT POINTS OF THE EXTREME ORIENT WHOSE OBSERVATIONS ARE RECEIVED DAILY BY CABLE, OR ARE EXPECTED TO BE SO RECEIVED FROM NOW ON.

Finally, in the Engraving LXII, we also indicate the stations at different points of the extreme orient and the Pacific Islands from which daily cable reports are received, or are expected to be received, without loss of time.

In the following tables we include all the stations, indicating by an asterisk those which have already sent, and are sending, their observations at least twice daily:

Station.	North latitude.		East longitude.	
	°	′	°	′
Ponapé (Carolinas Orientales)	6	46	158	[1]23
Yap Carolinas Occidentales)	9	29	138	05
*Cape St. James (Cochin China)	10	20	107	05
*Padarán (Cochin China)	11	35	109	09
*Nhatrang (Cochin China)	12	16	109	12
Guam (Marianas ó Ladrones)	13	28	144	14
Tourane (Annam)	16	07	108	13
*Haiphong (Tongking)	20	52	106	40
*Koshun (Formosa)	22	04	120	47
*Hongkong (China)	22	18	111	10
*Fainan (Formosa)	22	59	120	12
*Hokoto (Pescadores)	23	33	119	34
Swatow (China)	23	22	116	40
Taichu (Formosa)	24	02	120	40
*Tsigakijima (Liukiu)	24	20	124	07
*Amoy (China)	24	28	118	05
Faihoku (Formosa)	25	04	121	28
Foochow (China)	26	08	119	38
*Naha (Liukiu)	26	13	127	41
*Oshima (Linschoten)	28	23	129	30
Ningpo (China)	29	50	121	31
*Shanghai	31	14	121	29
*Kagoshima (Japan)	31	35	130	33
*Nagasaki (Japan)	32	44	129	52
Kochi (Japan)	33	33	133	32
*Tokyo (Japan)	35	41	139	45

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[1] We have taken this data from the general chart of the Pacific Ocean, occidental part, page a, published in Madrid by the section of hydrography in the year 1873.

The eight storm signals which are used by the Observatory of Manila, and which are reproduced in the plate facing this page, indicate as follows:

First.—Observatory announcement: Indication of distant tempest, whose direction is unknown. There will be time to change the sign in case the tempest comes nearer.

The port authorities advise: To prepare to strengthen moorings upon a change of the signals. Steamers should prepare their fires and be ready to get up steam. Smaller ships, or those without cover, will be notified not to venture outside the river.

Second.—Observatory announcement: A tempest whose center rests to the north, somewhat distant. Heavy winds must be expected from the third quadrant, perhaps between the west and south.

The port authorities advise: To strengthen moorings and to lower the topmast. Steamers should be all ready to get up steam. No risks should be taken in the bay with small or undecked craft. Bancos are prohibited from leaving the river.

Third.—Observatory announcement: A tempest whose center rests to the south, somewhat distant. Winds are expected from the second quadrant, perhaps between the east and south, which will not be strong as in the above case.

The port authorities advise: The same as before.

Fourth.—Observatory announcement: A tempest whose character is dangerous for the locality, but not imminent. Further notice will be given.

The port authorities advise: Strengthen the cables; lower the topmasts. Steamers should be all ready to get up steam. It is absolutely forbidden to embark in the bay or in bancos in the river. No banco or small craft without cover shall leave the river.

Fifth.—Observatory announcement: A tempest whose center rests very near the north. Violent winds must be expected from the fourth and third quadrant.

The port authorities advise: Strengthen the cables as much as possible. Steamers should get up steam, those of the bay in order to utilize their machinery to ease their moorings if necessary, or take refuge in Cavite; those of the river will do so in case the cables should break or it should be necessary to aid and ease their cables. It is absolutely forbidden to embark in the bay or river, and all movements of all kinds of craft during the time this sign is hoisted are prohibited.

Sixth.—Observatory announcement: A tempest whose center is very near to the south. Violent winds are expected from the first and second quadrant; will probably not be so strong as those of the above case.

The port authorities advise: The same as before.

Seventh.—Observatory announcement: Imminent tempest for the locality.

The port authorities advise: The same as above.

Eighth.—Observatory announcement: Great inundation.

Port authorities advise: Ships outside should not attempt to enter the river, and none now in the river should leave. The passing from one bank to the other in bancos or other small boats is prohibited during the time this signal is hoisted. The port guards will prohibit the departure of embarkations until the inundation has ceased, in order to avoid the dangers which result from not heeding this order.

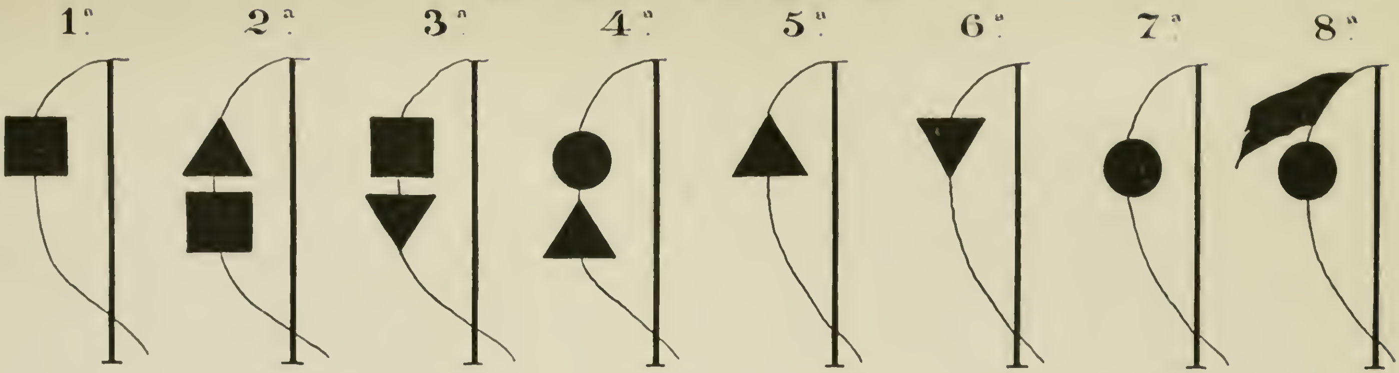
N. B.—First. When any of these signs are hoisted captains and shippers shall notify the port authorities or the nearest guard if they see a ship near them which is not well anchored. One ship in such a state may produce great havoc among the others.

Second. The flag floated above the globe to indicate the eighth sign may be of any color.

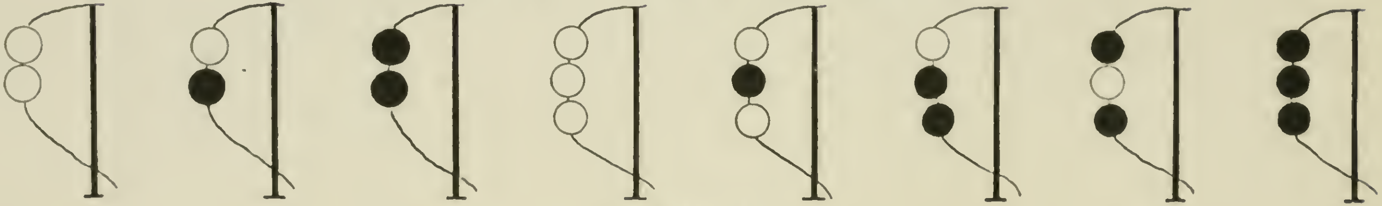
Third. The signal for the ships of the bay is horizontal and electric, situated in Malecon del Sur.

STORM SIGNALS AT THE PORT OF MANILA.

BY DAY.



BY NIGHT.



BY NIGHT {● – red light.
{○ – white light.

CHAPTER IX.

TORNADOES.

I.—PRELIMINARIES—TOPOGRAPHIC DESCRIPTION OF MANILA.

WHAT DO WE UNDERSTAND BY TORNADOES?

By the word tornadoes we generally mean those local tempests, usually of little duration, which appear accompanied by more or less imposing electric manifestations, assuming at the same time a sublime and terrific aspect. In chapter 5 we have occasionally mentioned these phenomena as partial reasons of the observed rains in Manila during certain months, and indicated the seasons of the year in which they are more frequent and of most intensity. Here we will state more facts on this point, but without the intention of making a complete study of such tempests, for to do this would require more time than we have to give to this subject, and more copies of the collected data in the different points of the archipelago. We will content ourselves with presenting some statistics regarding the number, intensity, and orientation of the tornadoes which have been observed from this observatory during the ten years from 1888 to 1897, briefly indicating some meteorologic phenomena related to them.

PERIOD EMBRACED BY OUR STATISTICS OF TORNADOES OBSERVED FROM THIS OBSERVATORY.

We said in Paragraph II of the first chapter that, in consideration of the fact that this observatory was invited to take part in the meteorologic exposition at Chicago, besides the works of Fathers Faura and Cirera, this congress was also presented with a memorial of Father Saderra Mata concerning the tornadoes in Manila. In this memorial we find complete catalogues of all the tornadoes which figure in the registers of this observatory during a period of five years from 1888 to 1892. Being desirous of benefiting by the observations in the published catalogues and statistics of Father Saderra, and of completing them by adding the other five years, namely, 1892–1897, it is necessary for us to adopt the system followed in the forming of said catalogues, and for this reason we have properly noted the following advice which precedes it, and will note some additional advice at its corresponding place.

Advice.—The apparatus of this observatory are consulted during all hours of the day and night, the state of the sky at the same time being observed. This necessarily implies the intervention of different observers, and from this fact results the change of critics in the precision of the circumstances of a phenomenon when it does not become objectively determinate. This must be kept in mind when studying the tornadoes, especially as to those that are distant and of which only the lightning is visible. The same cause of error exists in the precision of the routes.

TOPOGRAPHIC PECULIARITIES OF THE CAPITAL OF THE ARCHIPELAGO.

Before we proceed further with the study of the frequency, classification, and orientation of the tornadoes observed from Manila, we believe it would be of special interest and utility to present some topographical peculiarities of the capital of the archipelago, taken from the memorial of Father Saderra, before mentioned, which will serve without doubt to form a more complete idea of the electric tempests which prevail in this locality or in the neighboring regions.

From the tower of the observatory our view extends over the west of Manila to the bay, whose waters reach more than 20 miles, and to the ridge of Mariveles and the mountains of Bataan, which unite in the NW. with those of the provinces of Zambales and Pampanga. Between these and Mount Arayat, which stands solitary in the middle of the great plane, about 974 meters from the sea level, are discovered the great planes of the Pampanga, behind which are those of the Bulacan, while scarcely visible in the background are the heights of Tarlac.

Extending from the oriental brows of the Arayat are the planes of the same province, which extend far to the north by the province of Nueva Ecija, and it may be said that in this direction there is an unlimited view. We note that to the southeast of Mount Arayat is to be found the famous Pinac de Candaba. This takes its name from the large extent of low territories which are flooded by the rises in the rivers of Maasim, Garlan, San Miguel, and Bule, thus forming a temporary lake of about 8 or 10 miles in extent.

During the rainy season no notable diminution in the waters of this lake are observable, but from the beginning of November the drainage is considerable, so that by the end of January the territories bathed by this sea of sweet water are completely dry, with the exception of some canals which are lower than the level of the immediate rivers.

The view toward the oriental part, however, is much more limited, on account of the mountains of Bulacan, to the NNE., and by the ridges of San Mateo, Bosoboso, Antipole, and Talajala, upon which are thrown the Talim, a volcanic hill which rises in the middle of the waters of the grand lake of Bay, which remains to the southeast. In the west, with the exception of a few small heights, which surround the occidental part of the cited lake, the view extends uninterruptedly for more than 45 miles. On clear days, in the background of this panorama, majestically rises Mount Banajao, which some have believed to be the highest point in the archipelago, because it measures 2,233 meters above the level of the sea.

Farther to the south is detached another and much nearer mount, not so high, but of no less importance to be mentioned, on account of the reflection produced by it for the study of the geological composition. To the south the view is broken by the ridges which separate the provinces of Cavite and Batangas, which end at the most central part of Punta Santiago, while other ranges reach toward Punta Restinga, where they form a high coast upon the central plane at the entrance to the Bay of Manila. This bay is open at the occidental coast of the island of Luzon and communicates with the China Sea by means of a canal 10 miles wide, divided by the two islands of Corregidor and Pulo Cabella. The city of Manila is situated in the oriental extremity of the bay, 25 miles from the entrance of the bay.

Concerning what is of interest in the study of tempests besides the Pinac de Candaba and the lake of Bay, of which we have spoken, we should mention the Lake Bonbon. This is located to the south, behind the ridges of the province of Cavite, upon which sometimes is seen the smoke of a volcanic eruption from Taal, situated in the middle of the waters of the lake.

Again, finding ourselves in a watery region to the east and west, by elevated mountains the view extends to the north toward the interior of the island of Luzon for more than 50 miles. In the central part the Cordilleras are seen at a distance of 30 miles; Manila, about 50 miles, separated from the China Sea by a spacious bay, which is separated from the Pacific by a little greater distance than the territories of this province and those of the districts of Norong and the Infanta.

II.—YEARLY AND MONTHLY DISTRIBUTION OF TORNADOES IN MANILA.

Availing ourselves of the catalogue of Father Saderra and the records of this observatory, corresponding to the ten years from 1888 to 1897, we will give in Table CX the total number of tornadoes which we found consigned to each one of the months of the years of the said period.

Advices.—For the complete intelligence of this table, or rather, we should say, for the better understanding of this table, we have to advise that it may be possible to give afterwards the orientation of these tornadoes, and in order to follow the system laid down in the formation of this catalogue of the first five years, we have considered as different tornadoes the following: First, those which we have found consigned to different quadrants; second, those which have repeated themselves in the same quadrants; if they belong to a different class of tornadoes in agreement with the classification into three groups, which we will indicate farther on, but not considering those of the same class, even if they repeat themselves many times in the same quadrant. Besides (and this advice will serve likewise for Paragraph IV), in regard to the tornadoes in the locality, or those near by, we have considered them always as of the quadrant of their first appearance; and, when it is possible, we have not counted them twice, even in their movement of translation, they continued to vent into other quadrants.[1]

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[1] If these advices are taken at present, it will not call attention to the differences which are noted between the result of these tables and the monthly totals of the tornadoes, of which we have made mention several times in our meteorological bulletin from 1895 to 1897, which is the criterion we follow in considering these phenomena as only one, or as to two or three different tornadoes, and which is similar to what we have just indicated, as can be seen in the meteorological review of the month of May, 1895.

The observations being made, we give the following table:

TABLE CX.—*Annual and monthly distribution of tornadoes as observed from the Manila observatory, 1888–1897.*

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1888	2	......	14	21	93	56	22	48	86	55	13	9	419
1889	5	1	8	18	78	118	80	53	116	76	29	6	588
1890	6	7	10	31	118	72	76	98	32	43	11	8	512
1891	1	......	9	22	106	102	43	30	41	52	32	2	440
1892	4	6	14	41	121	128	90	165	48	62	17	10	646
1893	11	2	5	48	99	110	91	72	75	51	4	4	572
1894	......	......	2	39	115	68	74	68	48	52	8	5	479
1895	......	......	3	27	84	74	76	55	56	47	7	0	429
1896	......	......	12	17	59	98	56	32	57	39	7	1	378
1897	......	......	12	57	130	81	89	60	64	52	40	2	587
Total	29	16	89	321	1,003	907	697	621	623	529	168	47	5,050

MONTHLY DISTRIBUTION OF THE TORNADOES.

In the first place, see what Father Saderra says concerning this point, in studying the results obtained from only the tornadoes of five years, 1888–1892. Uniting by months the observed tornadoes during the five years, 1888–1892, we will deduce the fact that these meteors are very rare and sometimes absent during the months of January and February; are a little more frequent during the months of March and April, and extend to their maximum during the following months until October. In the other two months they occur with sufficient variety, there usually being a few tornadoes observed in December similar to those which occur in the second half of January.

Confining ourselves to the results which figure in the total of observed tornadoes, it will be seen that the minimum is to be found in the month of February and the maximum in the month of May, there being a notable difference in this month and the preceding one.

In the month of June a decrease begins to be noted, and we may say it continues until January, although during the month of July a smaller number of tornadoes occur than in the following month.

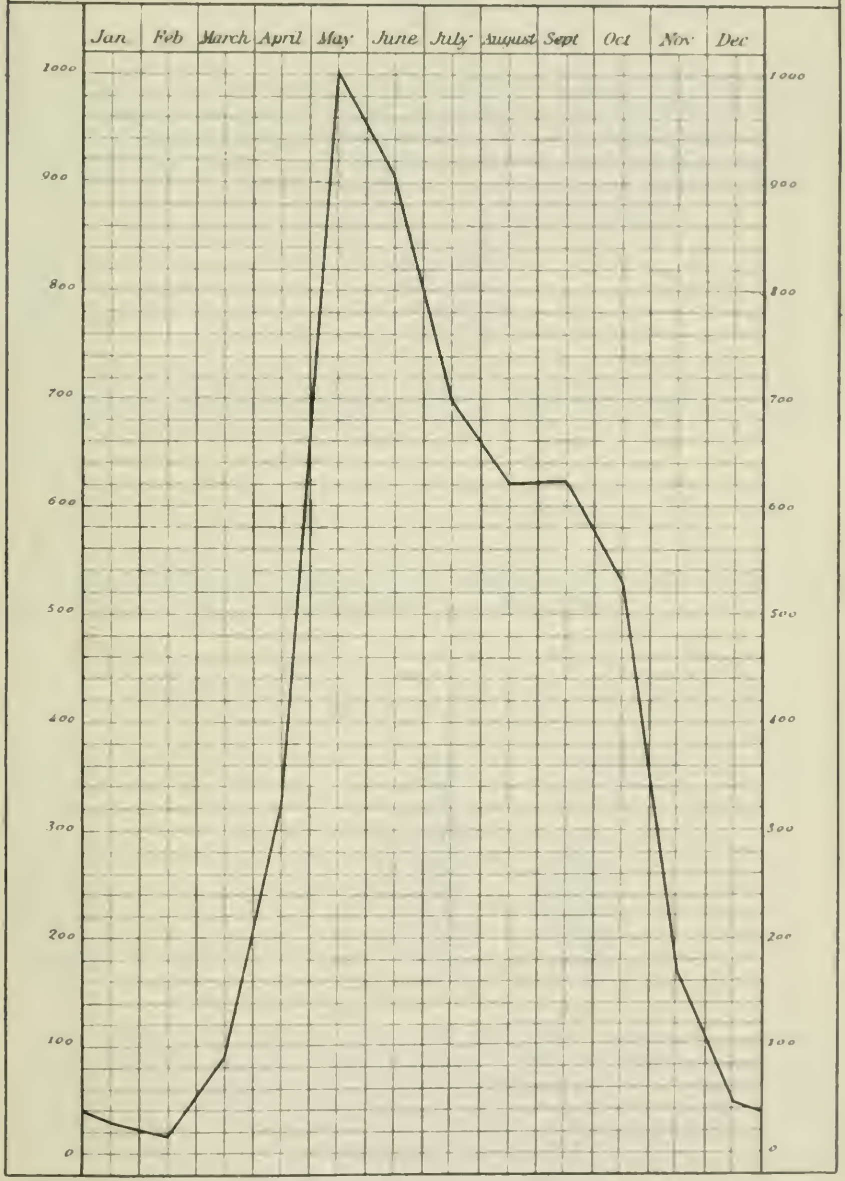
Now, let us look for a moment at the monthly totals deduced from ten years' observations, 1888–1897, as they appear in Table CX. It will be seen that the preceding lines are almost entirely to be applied to these new results, which have scarcely changed the monthly relations obtained with the tornadoes of the first five years. The only thing worthy of note is that in the last four years of the ten years we are considering there appears to be a pronounced decrease or diminution of these phenomena which, as we have stated, were apportioned to the months of December, January, and February, because during all of them we do not see registered in the record of the observatory any tornado, not even a distant one, in the months of January and February, neither in December of 1895, and only one in December of 1896, two in December of 1897, and five in December of 1894.

Besides this, the small anomaly which was observed during July with respect to the following disappears: In effect, the second five years have been, without exception, the ones in which a greater number of tornadoes were observed in July than in August.

PLATE LXIII.

MONTHLY DISTRIBUTION OF THE THUNDER-STORMS OBSERVED AT MANILA

1888-1897



[illegible]

From this it results that the total number of the ten years corresponding to that period is greater than the total of August. Between the total of August and the total of September there is only an insignificant difference, the latter being slightly greater.

TOTAL OF THE TORNADOES OF THE WHOLE TEN YEARS—YEARLY TOTALS.

The total number of observed tornadoes in all the ten years which corresponds to the period 1888-1897 reaches 5,050, with a resulting yearly average of 505, which amount does not differ much from the yearly average obtained during the first five years, which was 521.

How much the totals of each one of these years is separated from the yearly average can be seen in the following outline:

1888	86	1893	67
1889	83	1894	26
1890	7	1895	76
1891	65	1896	127
1892	141	1897	82

From this it appears that the year in which the greatest number of tornadoes occurred was 1892, showing a minimum total in the year 1890.

MONTHLY MAXIMA AND MINIMA OF THE WHOLE TEN YEARS.

In the following table we will include the maxima and minima of the whole ten years corresponding to each month:

Month.	Maxima.		Minima.	
	Number.	Year.	Number.	Year.
January	11	1893	0	1894, 1895, 1896, and 1897
February	7	1890	0	1888, 1891, 1894, 1895, 1896, and 1897
March	14	1888 and 1892	2	1894
April	57	1897	17	1896
May	130	1897	59	1896
June	128	1892	56	1888
July	91	1893	22	1888
August	105	1892	30	1891
September	116	1889	32	1890
October	76	1889	39	1896
November	40	1897	4	1893
December	10	1892	0	1895

The greatest frequency of the whole period is seen to be that of May, 1897, and the next is that of June, 1892. The small number of tornadoes occurring in the month of May, 1896, is notable, and is probably due to the many days we were under the influence of a cyclone, which, after having passed the Visayas, turned at the west of Luzon and crossed this island in the second branch of the parabola by way of the provinces of Ilocos and Cagayan.

III.—RELATIVE INTENSITY OF THE TORNADOES IN MANILA.

DISTRIBUTION OF THE TORNADOES INTO THREE GROUPS.

In order to distinguish in some manner the relative intensity of the tornadoes which are registered in this observatory during the ten years we have considered, we have divided them into three groups, in the following manner: First, tornadoes which rage in the locality, or very near; second, tornadoes which produce much thunder; and third, tornadoes which can only be perceived by the flashes of lightning or peals of thunder accompanied by lightning. We represent, in the first place, the first group by the letter T, the second by the letter L, and the third group by the letter R.

Having agreed upon this simple classification, as a result of our calculations we include in Table CXI the total number of tornadoes of each month during the period from 1888 to 1897, distributed into the three groups which we have just indicated.

Table CXI.—*Relative intensity of storms observed from Manila during the decade 1888–1897.*

Year.	January.			February.			March.			April.			May.			June.		
	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.
1888	....	....	2	....	....	....	....	7	7	3	11	7	3	38	52	1	31	24
1889	1	3	1	....	1	....	....	4	4	....	9	9	....	39	39	7	49	62
1890	....	....	6	....	1	6	....	....	10	....	7	24	11	48	59	7	19	46
1891	....	1	....	....	....	....	....	1	8	1	3	18	8	29	69	9	48	45
1892	....	4	....	1	1	4	....	2	12	....	5	36	10	52	59	9	39	80
1893	....	1	10	....	1	1	....	1	4	2	11	35	7	31	61	5	23	82
1894	....	....	....	....	....	....	1	....	1	....	4	35	4	31	80	2	20	46
1895	....	....	....	....	....	....	....	1	2	1	7	19	7	24	53	7	17	50
1896	....	....	....	....	....	....	1	2	9	....	3	14	4	21	34	10	34	54
1897	....	....	....	....	....	....	....	2	10	3	14	40	9	42	79	4	18	59
Total	1	9	19	1	4	11	2	20	67	10	74	237	63	355	585	61	298	548

Year.	July.			August.			September.			October.			November.			December.		
	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.	T.	L.	R.
1888	1	11	10	5	29	14	5	49	32	2	26	27	....	6	7	....	4	5
1889	8	36	36	4	19	30	8	46	62	1	25	50	....	11	18	....	4	2
1890	7	27	42	7	46	45	3	12	17	1	19	23	....	1	10	....	1	7
1891	3	15	25	3	12	15	5	24	12	2	17	33	1	14	17	....	....	2
1892	6	31	53	5	40	60	....	18	30	....	21	41	....	3	14	1	3	6
1893	11	41	39	6	28	38	4	19	52	2	4	45	....	1	3	....	....	4
1894	7	27	40	6	19	43	4	12	32	4	18	30	....	1	7	....	2	3
1895	11	29	36	9	17	29	9	16	31	3	19	25	1	1	5	....	....	....
1896	3	18	35	5	10	17	....	28	29	2	6	31	....	1	6	....	....	1
1897	9	36	44	10	21	29	5	22	37	2	12	38	3	15	22	....	2	....
Total	66	271	360	60	241	320	43	246	334	19	167	343	5	54	109	1	16	30

MONTHLY AND YEARLY TOTALS CORRESPONDING TO THE THREE GROUPS OF OUR CLASSIFICATION.

In the monthly amount of the whole period, which we give at the end of this table, it will be seen at the start that the total number of tornadoes of the R group is much greater than the total number of L tornadoes, there being very few which rage in or near the locality.

The yearly amount of the ten years can be seen in the following outline:

Year.	T.	L.	R.
1888	20	212	187
1889	29	216	313
1890	36	181	295
1891	32	161	244
1892	32	219	395
1893	37	161	374
1894	28	131	347
1895	48	131	250
1896	25	123	230
1897	15	184	358
Total	332	1,755	2,963

This means that the total number of tornadoes during the ten years resolves itself into the numbers 332 T, 1,755 L, and 2,963 R, resulting for each year in the following averages:

Tornadoes:	*Yearly average.*
T	33
L	176
R	296

ANOMALY OF THE YEAR 1888.

When we closely examine the yearly totals of the tornadoes which correspond to the three groups mentioned it will be observed that in the year 1888 an anomaly exists which we will designate here by the same terms used by Father Saderra in his memorial, namely:

> In this year, 1888, we note an anomaly which makes us suspect that many of the tornadoes R have not been recorded for the above reasons.

And again:

> In effect, in four or five of the catalogued years, the observed number of tornadoes R is much greater than the tornadoes L, which does not occur in 1888, but before this it occurs in a very notable way. On the other hand, it is true that local tornadoes have occurred in smaller numbers, and these are not so easy to pass without observation, nor do their number invert the frequency of the other years.

DIURNAL DISTRIBUTION OF THE DIFFERENT CLASSES OF TORNADOES.

Since it is impossible for us to analyze the diurnal distribution of tornadoes closely here, for want of time, we will give only a few comments in regard to this point. In general it may be said that the cases are rare in which some of these electric phenomena have been observed from 7 to 11 in the morning. At this hour approximately the tempests begin to rise and increase in force during the two months mentioned, in which they are most frequent, and are accompanied by great cloud-bursts and high winds, which gather in force as they move toward the zenith of the horizon, but not reaching their maximum force until about midday, or a little after. The greater number of tornadoes T and L rise in the intervening hours between midday and 10 or 11 p. m. During the later hours of the night the tornadoes R are most frequent, and tornadoes L not quite so frequent. In the early hours of the morning thunder is frequently heard, though seldom followed by lightning or storms.

IV.—ORIENTATION OF THE TORNADOES.

DIVISION OF THE TORNADOES INTO FOUR GROUPS ATTENDING ITS DIVERSE ORIENTATION.

In order to investigate the general orientation of the tornadoes we have grouped the 5,050 tornadoes of the ten years which we are studying into four groups, according to whether they were observed on the first, second, third, or fourth quadrant, and we have in this manner formed Table CXII.

TABLE CXII.—*Orientation of the tornadoes observed at Manila during the decade 1888 to 1897.*

Year.	January.				February.				March.			
	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.
1888	1	......	......	1	......	......	......	......	4	3	1	6
1889	2	1	2	......	1	......	......	......	3	......	......	5
1890	......	4	......	2	1	1	2	3	4	2	......	4
1891	1	......	......	......	......	......	......	......	2	1	......	6
1892	1	1	......	2	1	......	1	4	4	4	......	6
1893	4	2	......	5	......	......	......	2	2	1	......	2
1894	......	......	......	......	......	......	......	......	1	......	......	1
1895	......	......	......	......	......	......	......	......	1	1	......	1
1896	......	......	......	......	......	......	......	......	2	2	2	6
1897	......	......	......	......	......	......	......	......	4	2	1	5
Total	9	8	2	10	3	1	3	9	27	16	4	42

Year.	April.				May.				June.			
	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.
1888	4	5	2	10	25	24	18	26	17	16	11	12
1889	7	5	......	6	21	18	11	28	32	33	29	24
1890	4	8	5	14	29	29	33	27	15	23	15	19
1891	7	2	......	13	32	24	20	30	25	20	31	26
1892	6	11	6	18	34	33	25	29	31	35	34	28
1893	13	11	5	19	26	25	22	26	20	28	28	34
1894	4	8	7	20	32	33	24	26	17	16	19	16
1895	9	4	6	8	24	22	18	20	18	19	17	20
1896	5	3	3	6	23	13	11	12	30	25	19	24
1897	15	14	10	18	43	30	26	31	17	21	17	26
Total	74	71	44	132	289	251	208	255	222	236	220	229

Year.	July.				August.				September.			
	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.
1888	3	8	3	8	15	13	7	13	23	22	18	23
1889	25	26	15	14	16	13	9	15	33	27	27	29
1890	20	24	14	18	32	22	21	23	11	9	4	8
1891	10	7	11	15	8	4	5	13	18	8	4	11
1892	25	19	23	23	28	26	23	28	14	16	10	8
1893	17	27	24	23	22	21	20	9	27	18	10	20
1891	27	19	14	14	20	18	12	18	17	10	10	11
1895	23	15	19	19	20	15	8	12	20	13	8	15
1896	15	16	9	16	9	7	9	7	18	13	10	16
1897	29	25	17	18	15	18	13	14	24	15	12	13
Total	194	186	149	168	185	157	127	152	205	151	113	154

TABLE CXII.—*Orientation of the tornadoes observed at Manila during the decade 1888 to 1897*—Continued.

Year.	October.				November.				December.			
	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.
1888	15	17	11	12	6	1	3	3	2	1	2	4
1889	23	20	14	19	10	5	5	9	6	.....	.....	.....
1890	13	9	11	10	3	2	3	3	2	2	1	3
1891	11	13	11	11	7	11	7	7	.....	2	.....	.....
1892	12	12	21	17	3	7	6	1	2	1	5	2
1893	19	12	9	11	.....	1	2	1	.....	1	2	1
1894	12	12	11	17	1	1	5	1	1	2	1	1
1895	16	13	8	10	2	.....	3	2	.....	.....	.....	.....
1896	9	8	7	15	1	1	2	3	.....	1	.....	.....
1897	13	12	9	18	10	4	12	11	1	.....	1	.....
Total	143	128	115	143	43	33	48	44	14	10	12	11

QUADRANTS OF THE MAXIMUM AND MINIMUM FREQUENCY OF TORNADOES.

As can be seen by the monthly totals which we give, tornadoes are least frequent in the third quadrant, the only exceptions being in the months of February, November, and December, in which the second quadrant shows a smaller total. The greatest frequency has been observed in the first quadrant in the months of May, July, August, September, October, and December, and in the fourth quadrant in the months of January to April, inclusive; in the second in June, and in the third in November.

DISTRIBUTION OF THE YEARLY TOTALS, AS SEEN BY THEIR ORIENTATION, DURING THE PERIOD OF TEN YEARS.

The yearly totals of the ten years which we are considering are distributed also as to the different orientation in the following outline:

Year.	First quadrant.	Second quadrant.	Third quadrant	Fourth quadrant.
1888	115	110	76	118
1889	179	118	112	149
1890	134	135	109	134
1891	121	92	72	135
1892	161	165	154	166
1893	150	117	122	153
1894	132	119	103	125
1895	133	102	87	107
1896	112	87	72	105
1897	171	141	118	157
Total	1,408	1,248	1,045	1,349

The results in all cases are identical with those obtained by Father Saderra regarding the tornadoes of the first five years; or, better said, the greater number, 1,408, corresponds to the first quadrant; the intermediate, 1,349, to the fourth quadrant, and the other two, 1,248 and 1,045, to the second and third quadrants, respectively.

LOCATION OF THE DIFFERENT CLASSES OF TORNADOES.

This relates merely to the location of tornadoes in general, irrespective of other classification. Let us consider now for a few moments the location (orientation) of the different classes of tornadoes, of which we give the following outline:

Year.	Tornadoes T.				Tornadoes L.				Tornadoes R.			
	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.	1st quadrant.	2d quadrant.	3d quadrant.	4th quadrant.
1888	9	5	1	5	67	58	34	53	39	47	41	60
1889	12	15	2	5	82	65	39	60	85	68	71	89
1890	15	14	3	4	61	46	35	39	58	75	71	91
1891	7	8	6	11	54	39	30	41	60	45	56	83
1892	15	9	3	5	64	53	43	60	82	104	108	101
1893	14	9	5	9	55	39	30	37	81	99	87	107
1894	20	3	2	3	41	35	28	30	71	80	73	92
1895	21	7	9	11	42	38	19	32	70	57	59	64
1896	10	9	4	2	42	24	22	35	60	56	46	68
1897	16	11	5	13	69	39	35	41	86	91	78	103
Total	139	90	40	63	577	435	315	428	692	723	690	858

As seen by this outline, we have 332 tornadoes T, of which 139 belong to the first quadrant, 90 to the second, 63 to the fourth, and 40 to the third. Of the 1,755 tornadoes L, the smallest number (315) belong to the third quadrant, and the greatest number (577) to the first quadrant, there being a notably small difference between those of the second (435) and those of the fourth (428). The distribution of the 2,963 tornadoes R in the four quadrants is sufficiently different. The maximum (858) belongs to the fourth; following this, in descending order, the second, first, and third (723, 692, and 690).

V.—ATMOSPHERIC PRESSURE AND SOME PHENOMENA RELATIVE TO TORNADOES.

SUDDEN ASCENSION OF THE BAROMETER DURING THE TORNADOES.

It is an occurence frequently observed, and which can repeatedly be seen, especially consigned to the meteorological reviews and in the outlines of the general observations of our monthly bulletin, that when a tornado begins to discharge itself upon our station or very near by, it will be noted in the curve of the barograph, which makes some brusque ascensions, exceedingly rapid, and which reach 2 or more millimeters in the short interval of a few minutes. In the engraving LXIV we present some facsimiles of curves of this kind. The most notable ascensions registered during the thirteen years in which the Spring-Fues barograph has been in use in this observatory were caused by the tornadoes on the 21st of May, 1892, and on August 28, 1897.

TORNADO OF MAY 21, 1892.

This first one is described by Father Saderra in the following terms:

> On the afternoon of the 21st day of May, in the year 1892, a tempest was raging in Manila which terrified its inhabitants by the number of electric sparks which accompanied it and by the tremendous peals of thunder. It began in the second quadrant with strong winds from the SW. The rain began to fall a little before 5 p. m. with such abundance that there were collected 60 millimeters of water in thirty minutes.

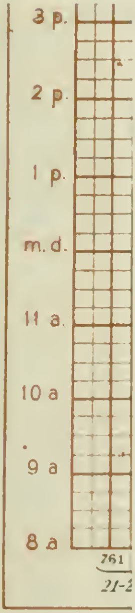
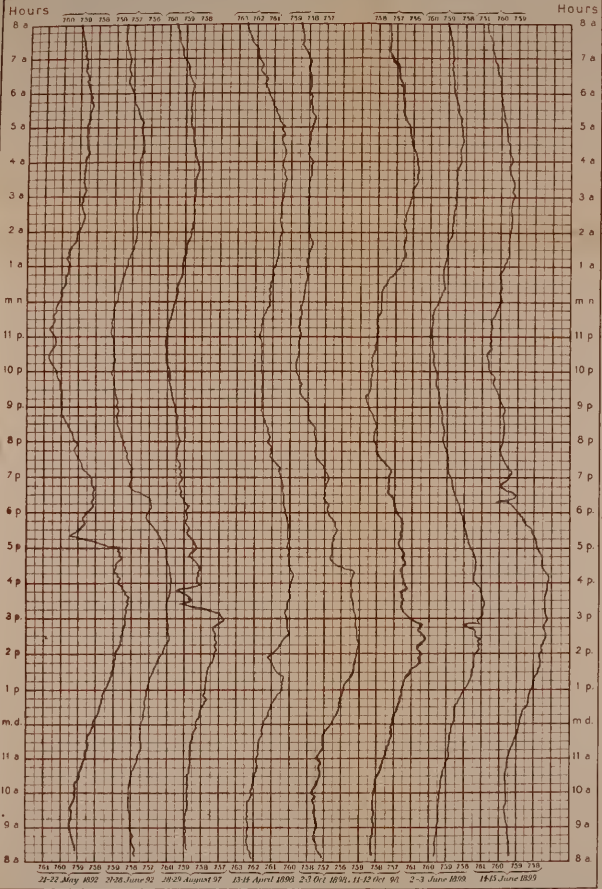

3 p.
2 p.
1 p.
m. d.
11 a.
10 a
9 a
8 a
761
21-2

PLATE LXIV

FACSIMILE OF SOME CURVES REGISTERED BY THE SPRUNG-FUESS BAROGRAPH OF THE MANILA OBSERVATORY IN THUNDERSTORMY DAYS



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> The augment of atmospheric pressure was such that in twenty minutes the barometer ascended to 3 millimeters. The aspect produced by the electric emanations was truly sublime.
>
> In one point of the sky, situated to our NW., appeared to be stored the sparks, which remained there continuously. In this region we could see repeatedly a division of rays of imposing fullness. At times when a ray divided (bifurcated) the repetition of the sparks was continued until the fourth, or maybe the fifth, bifurcation, so that, in other words, it appeared as if the rays were produced in bunches. In this way the tempest continued for nearly an hour, and, as it went away toward the NW., the lightning of the storm marked and reflected its course. This tornado is remembered by the inhabitants of Manila especially for its similarity to the one which occurred on May 29, 1873, about which it may be read to-day in the notes of this observatory that there fell upon the country more than 50 bolts of lightning.

TORNADO OF AUGUST 28, 1897.

The other notable tornado, namely the one of August 28, 1897, was described by us in the meteorological review of the said month and year in the following words: The focus of the tornado of the 28th day remained, from before 3 p. m., to the south of Manila, from which were heard the distant thunders, having already extended itself upon the area of rain for the second and third quadrant. From a little after 3 p. m. the whole horizon was completely enveloped in water, the curves of the barometer indicating that the tempest, which was seen then at the SSE., was acquiring extraordinary proportions. The mercurial column was ascending rapidly from 3.10 p. m. to 3.22 p. m., or, in other words, in the short space of twelve minutes 2.10 mm. was registered by the barometer, and there appeared to be taking place the most intense emanations and discharges after this brusque ascension of the atmospheric pressure. The rain was plentiful, since from 3.14 to 3.30 p. m. there was collected in the pluviometer 44 mm. of water in this short space of sixteen minutes. The strong winds of the south acquired their velocity from 3.30 to 3.45 p. m., in fifteen minutes attaining a velocity of 13 kilometers, or at the rate of 14 meters per second.

The tempest at 4 p. m. went away toward the west and to the fourth quadrant, leaving behind it an extraordinary humidity in the atmosphere which did not diminish until 6 a. m. of the following day.

The rains and squalls continued at intervals until 7 p. m., being the cause of the long and prolonged spiral which up to this hour was seen in the barograph.

ATMOSPHERIC CURRENTS—THE HURRICANES AND TORNADOES.

It has been generally observed that there is a greater number of tornadoes, presenting considerable electricity, when the winds are variable and when the position of the atmospheric currents change. From this cause it results that the hurricanes rarely occur with electric phenomenon inside of the temporal body where the cyclonic currents are plainly established, but change frequently in the exterior limits of the cyclone, when there is yet great opposition between the normal currents of the atmosphere and those which must establish themselves by virtue of the laws of cyclonic circulation. See what Father Algué says on this point in the Meteorological Review of June, 1894:

> The electric manifestations augment, for the reason that the currents have small variety and stability, so that when the superficial currents or those of the clouds are stably established the electric meteors diminish in such a manner that they disap-

pear altogether, as happened on the 23d day and from the 25th to the 30th days, during which they were all perfectly under the influence of the atmospheric depression. Nothing contradicts this assertion, as observed in the central body of the hurricane, for, outside of there being the electric phenomenon, which rarely occurs in said region, experience teaches that it is well known that near the arc of absolute calm there exists a void region of relative calm in which not a few times changeable winds are observed; on the other hand, it is very possible that said electric meteors were the effect of the extraordinary frictional forces which are the cause of the vehemence of the superficial currents of this region. In change the electric phenomenon is frequent and impotent in the last breath of the cyclone, because, being in a body of the exterior region of the tempest, the force of current is found to be much greater. This agrees with what we have several times said, namely, that the most terrible tornadoes have been the forerunners of atmospheric perturbations. And Father Viñes also says, in his Notes upon the Hurricanes of the Antilles, it is a phenomenon as constantly observed (the failing of the electric discharges in the body of a cyclone) that if sometimes the echo of thunder is heard or the effulgency of lightning is perceived, the tempest will be well predicted, and this is taken as a sign of its rapid separation. Among all the country people this opinion exists. The report of thunder and the song of the cock are the barometers of the white countryman of Cuba during the tempests, and it may be said that this barometer never deceives him. If the thunder is not heard and the cock does not crow, it is taken as a sure sign that the tempest is of great force and will last yet a while; but from the moment in which he hears the joyful cry of the cock or the report of thunder, for him the tempest is ended.

CLOUDINESS (SURFACE OR LEVEL).

According to Father Saderra, tornadoes which develop in a calm or clear sky may be distinguished from those which develop when the heavens are covered with a veil of clouds more or less thick. On calm and clear days their points of origin, perhaps the theater of a tempest, often appear indicated from early morning by means of a certain class of clouds somewhat lower than cirrus clouds but very similar in form to them.

Sometimes they are seen whirled around a focus where they radiate without extending much; others like the tail feathers of a cock and the precursors of cyclones, or cyclonic disturbances, extend themselves to great distances in the form of converging borders toward one point, in which they are seen confounded with the tempestuous clouds which do not generally occur with the cirrus and which precede the cyclone; others, instead of different borders, present a solid trunk or form and radiate beautiful ramifications, to which we give the name of aborisation or tree form. The starting points of these aborisations usually indicate the centers of the tempest.

Likewise, the disturbances of which we are speaking often occur with the apparition of a great mass of cumulus clouds, which, spreading themselves in extraordinary proportions over the horizon, reach almost to the zenith. In many instances they do not lose the spherical and gigantic forms which are proper to them, but generally it is observed that the forms above mentioned are substituted by others flattened and drawn out by the currents which draw them.

ELECTRICITY.

We will conclude with a few words concerning the electricity which is accustomed to develop in this class of disturbances. What we say is taken from the already cited memoir on "Tornadoes in Manila." It is very difficult to make proper observation of this electricity. In the first place, tempestuous clouds are seen at great distances that without doubt contain electric phenomena, which are not so perceptible during the day, but as night comes on the aspect of the clouds is illuminated by continuous emanations of electricity, and these phenomena are sometimes prolonged at some points until the following day hides the splendor of the lightnings.

Concerning the number of these lightning flashes, we have observed during a tornado that was raging in the west, in the mountain of Mariveles, that the lightning flashes repeated themselves 52 times in one minute.

PAPER NO. XXII.

CHRONOLOGY.

HISTORICAL AND CHRONOLOGICAL NOTES CONCERNING THE PHILIPPINES.

EXPEDITION OF HERNANDO DE MAGALLANES.

1519-1522.

1519. Magellan's flotilla sails from Seville.
1520. Magellan passes the strait which is named for him.
1521. Magellan lands at Butuan, in the north of Mindanao; raises the cross on a small hill, and celebrates mass for the first time in the Philippine Islands. Magellan takes possession of the island in the name of the King of Spain. Alliance between Hamabar, the King of Cebu, and Magellan. Death of the latter on the small island of Mactan. Duarte de Balbosa and twenty-six companions are treacherously assassinated at a banquet by order of Hamabar.
1522. Remnants of the expedition reach Seville in the ship *Victoria*, commanded by Don Juan Sebastian del Cano, thus completing the first circumnavigation of the globe.

EXPEDITIONS OF LOAISA, SAAVEDRA, AND VILLALOBOS.

1525-1549.

1525. The expedition of Frey Garcia Jose Loaisa sails from Coruña.
1526. Loaisa passes the Strait of Magellan, where a violent hurricane scatters part of his ships. Loaisa and Sebastian del Cano die on the Pacific. Capitana goes to Mindanao, and upon attempting to reach Cebu is driven by tempests to the Molucas.
1527. Expedition from Mexico under the leadership of Alvaro de Saavedra.
1528. Saavedra arrives at Mindanao, where he provides himself with stores, and then goes to the Moluccas.
1542. The armada of Ruy Lopez de Villalobos sails from the port of Juan Gallego in Mexico.
1543. Villalobos reaches southern Mindanao. He gives the island of Leyte the name "Filipina," which is afterwards extended to the entire archipelago. Various causes compel him to touch at the Moluccas, contrary to his wish and to that of his King.
1549. The remnants of the expedition of Villalobos reach Spain.

DON MIGUEL LOPEZ DE LEGOZPI.

1564-1572.

1564. The armada of Legozpi raises anchor at Natividad in Mexico. Fr. Andres de Urdaneta and other Augustin monks join the expedition.
1565. The islands of Leyte, Caniguing, Bohol, and Mindanao are visited and the flotilla then anchors at Cebu. Distrust and hostility of those islanders. The finding of the Santo Nino (Holy Child), the submission of the inhabitants of the island. The return of Father Urdaneta to Spain in order to give information to King Philip II.
1567. Legozpi sends his tender to Mexico under command of Juan de la Isla. Father Gamboa embarks in order to ask for more monks.
1568. Two galleons arrive at Cebu with troops, munitions and arms, and with them comes Don Juan de Salcedo, called the Hernan Cortes of the Philippines. Portuguese squadron, under command of Gonzalo Pereira, anchors off Cebu. The purposes of the latter are frustrated by the wise firmness of Legaspi.
1569. Legaspi transfers his encampment to Panay. Three vessels, commanded by Juan de la Isla arrive with dispatches from the King, conferring on Legozpi the governorship of the islands and the title of adalantado.
1570. An expedition under the orders of Don Martin de Goiti and Don Juan de Salcedo sets forth from Panay in order to study the conditions about Manila. Favorable reception of the Spaniards by Rajah Lacandola and Rajah Soliman. Treachery of the latter and his destruction. Return of the Manila expedition to Panay.
1571. Legazpi takes possession of Manila. The finding of the image of Our Lady of Guia in Ermita. Subjugation of certain provinces of Luzon by Don Martin de Goiti and Don Juan de Salcedo. Legozpi establishes commercial relations with the Chinese. Arrival of two ships with reenforcements at Cebu.
1572. Subjugation of new provinces by Salcedo. Death of Legazpi.

DON GUIDO DE LAVEZARES.

1572-1575.

1572. Complete submission of Zambales, Pangasinan, and Ilocos to Goiti.
1573. Submission of Camarines to Salcedo.
1574. Attack of the Chinese pirate Li-Ma-Hong on Manila. Heroic defense. Opportune arrival of Salcedo and defeat of Li-Ma-Hong.
1575. Salcedo attacks Li-Ma-Hong at Lingayen. Shameful flight of Li-Ma-Hong.

DON FRANCISCO DE SANDE.

1575-1580.

1576. Early death of Salcedo.
1577. Arrival of the first expedition of Franciscan monks.

1578. Fortunate expedition of Sande to Borneo. He restores its legitimate King to the throne, and the latter offers vassalage to Spain. Jolo and Mindanao tributaries (to him).

DON GONZALO RONQUILLO.

1580-1583.

1580. The Chinese are compelled to live together under the cannons of Fort Baybay.
1581. Arrival at Manila of its first bishop, Fr. Domingo Salazar. With him comes the first party of Jesuits. Beginning of work upon the cathedral. Second expedition to Borneo to restore the King to his throne.
1582. Victory won by Don Pablo Carrión in Cagayan over the Japanese corsair *Taifusa*. Expedition to Ternate under command of Lorenzo de Cartagena. Sickness decimates the troops. Father Alonzo Sanchez is sent to Macao to bring it about with the Portuguese of said colony to recognize Don Philip II as King, since Portugal had been added to his Kingdom.
1583. Death of Ronquillo. During his funeral ceremonies the temple of San Augustin burned, and the fire spreading to the citadel, two-thirds of Manila were destoyed.

DON DIEGO RONQUILLO.

1583-1584.

The building up of Manila. Charity of the governor in aiding the needy. Pacification of certain towns which had revolted because of the excesses of the military commander.

DON SANTIAGO DE VERA.

1584-1590.

1584. Establishment of the royal audiencia of the Philippines. The governor, under ample authority from the King, checks the abuses of military leaders. Construction of a stone fortress according to the plans and under the direction of Father Sedeno, of the Company of Jesus.
1585. Unfortunate expedition to Ternate. A conspiracy provoked by thievish Moros is discovered among the natives of Pampanga and Manila. Changes in Cagayan and Ilocos. Capture of the ship *Santa Ana* by the English corsair, Thomas Echadesch.
1586. Father Alonzo Sanchéz, a Jesuit, commissioned by the ecclesiastical and secular States and by order of the governor, is sent to Spain to obtain from the King the measures which good government and the prosperity of the islands demanded.
1587. Arrival of the first expedition of Dominican monks. Establishment of an artillery foundry. Foundation of a hospital for Spaniards.

DON GOMEZ PEREZ DASMARIÑAS.

1590-1593.

Construction of the walls of Manila and of Fort Santiago. Reorganization of the armada.

1590. Suppression of the royal audiencia by royal decree. Establishment of the College of Santa Potenciana for the orphans of military men. Disputes with Bishop Salazar.

1591. Voyage of the latter to Spain. The arrival at Manila of Faranda, the ambassador of Taicosama, the Emperor of Japan.

1592. Dasmarinas sends as ambassadors to the Emperor of Japan, the Dominican Father Cobo and Captain Lope de Llanos.

1593. New embassy to Japan. Coming of the King of Siao to Manila in order to offer obedience to King Philip II, to whom he cedes the island, and further to ask the aid of the Spaniards against the pagans of Ternate. Strong expedition to the Moluccas, under command of Dasmarinas, to help the King of Siao. Dasmarinas is assassinated by Chinese oarsmen at Point Santiago.

DON PEDRO DE ROJAS (PRO TEM.).

1593.

1593. The unfortunate death of Dasmarinas becomes known in Manila, and Don Pedro de Rojas, who was previously a councilor, takes over the government. At the end of thirty-nine days he resigns it to Don Luis Perez Dasmarinas, who was designated by his father, Don Gomez, under authority given him by royal cedula.

DON LUIS PEREZ DASMARINAS.

1593-1595.

1593. Suspicions aroused by large number of Chinese junks which arrive at Manila.

1594. An embassy sent to China to obtain the giving up of the assassins of Don Gomez Perez Dasmarinas without result. Foundation of the Obra Pia de la Misericordia by the priest, Don Juan Fernandez de Leon.

1595. Daring expedition of the governor to Nueva Viscaya, Isabela, and Cagayan, which results in the subjugation of those regions.

DON ANTONIA DE MORGA.

1595-1596.

1595. By virtue of a royal cedula each religious order has assigned to it the provinces in which it may exercise administration over spiritual affairs.

1596. Expedition to Mindanao, under the command of Capt. Rodriguez de Figueroa. This officer ascends the Rio Grande. At Buhayen a Moro treacherously kills him. There arrives at Manila the admiral's ship, of a squadron which had set forth from Callao to colonize the Solomon Islands, under command of Alvaro Mendana de Neira, who had died during the voyage.

DON FRANCISCO TELLO DE GUZMAN.

1596-1602.

1597. Don Juan Ronquillo goes to Mindanao to take the place of Figueroa. He destroys the fleet of Moro boats from Ternate, which came to the help of the Moros in Mindanao, and as a result of this victory the Moros of Mindanao and Jolo become vassals of Spain. Ronquillo, with great lack of judgment, abandons the acquired territory. News is received at Manila that the ship *San Felipe* has been driven to Japan; that Taicosama has perfidiously taken possession of the rich cargo which she carried, and that a number of monks had suffered martyrdom at Nagasaki.

1598. Dispatches are received, creating the archbishopric of Manila, and the bishoprics of Cebu, Nueva Caceres, and Nueva Segovia. Reestablishment of the royal audiencia. Contrary to the opinion of the audiencia, Tello orders the evacuation of the fort of La Caldera in Mindanao. An expedition fitted out and directed by Don Luis Gomez Dasmarinas sets forth to aid the King of Camboja, and is destroyed by tempest.

1599. A powerful fleet of Moro pirates infests the coast of Cebu, Negros, and Panay, causing great loss of life and property.

1600. A great naval victory off Mariveles over the Dutch corsair, Oliveria Van Noort. A fleet of Moro pirates attacks the town of Arevalo, in Iloilo, and is defeated. Earthquake at Manila.

1601. Foundation of the College of San Jose, under the direction of the Jesuits.

1602. Expedition to Jolo under command of Gallinato. After having accomplished something it returned for lack of supplies.

DON PEDRO BRAVO DE ACUNA.

1602-1606.

1602. Commercial relations are established with Daifusama, Emperor of Japan.

1603. A tremendous conflagration destroys a third part of Manila. Uprising of 20,000 Chinese. Spaniards, natives, and Japanese unite and completely overcome the Chinese.

1606. Fortunate expedition to the Moluccas. The record by Bravo de Acuna against the Dutch. Don Juan Esquivel remains as governor of Ternate.

INTERREGNUM. DON CRISTOBAL TELLEZ (IN CHARGE OF MILITARY AFFAIRS). THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1606-1608.

1606. The first mission of Recoleto monks arrives. Uprising of the Japanese. They are conquered and are prohibited from living in future together in one ward.

The Dutch corsair, Blancardo, is defeated and captured by Don Pedro de Heredia. Blancardo is taken to Ternate; he obtains his liberty by paying a heavy ransom, but later on he is again made prisoner and taken to Manila.

DON RODRIGO VIVERO (PRO TEM.).

1608-1609.

During his short governorship of nine months Vivero introduces some modifications in the administrative branch.

DON JUAN DE SILVA.

1609-1616.

1609. This governor begins by very actively improving the fortifications, casting heavy guns, and constructing vessels. The Dutchman, F. Witter, orders a landing at Oton (in Panay), but Don Fernando de Ayala, who had laid in ambush near the beach, falls unexpectedly upon the Dutch, who had disembarked, and destroys them.

1610. F. Witter takes up a position off Mariveles, and makes prizes of various Chinese and Japanese vessels. Defeat and death of Witter at Mariveles brought about by a Spanish squadron, under command of Don Juan de Silva. Rich booty captured from the Dutch.

1611. Arrival at Manila of the monks of San Juan de Dios, and their return to Mexico.

1614. Japanese driven from their country on account of professing the Catholic faith are received with great warmth at Manila.

1615. Ruy Gonzalez de Segueira arrives at Manila with reenforcements, coming by way of the Cape of Good Hope. The Jesuit Fathers, Gomez and Rivera, are sent by the governor to Goa to ask of the Viceroy his cooperation in Silva's plan of sending a strong armada against the Dutch.

1616. Don Juan de Silva sails at the head of a powerful armada against the Dutch. The little squadron of the Viceroy of India is burned by the Portuguese before it falls into the hands of the Dutch. The latter avoid the attack of the Spanish armada. Silva arrives at Malacca, where he is received in triumph as a liberator. Silva dies shortly after his arrival at Malacca. Return of the squadron to Manila.

INTERREGNUM. DON ANDRES ALCAZAR (IN CHARGE OF MILITARY AFFAIRS); THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1616-1617.

1616. The Dutch Admiral Spielberg bombards Iloilo. He disembarks and is defeated by Diego Quinones. A little fleet of twenty-four canoes, manned by Moros, allies of the Dutch, is destroyed by Flores in Punta Potol.

1617. A naval combat takes place at Playa Honda, in which Spielberg is completely defeated by Don Juan Ronquillo.

CHAPTER II.

SECOND PERIOD—FROM THE NAVAL COMBAT OF PLAYA HONDA (1617) TO THE DISMISSAL OF GOVERNOR ZABÁLBURU (1709).

DON GERONIMO DE SILVA (INTERREGNUM).

1617-1618.

1617. A little fleet is stationed at Iloilo to intercept the Moro piratical expedition.

DON ALONZO FAJARDO.

1618-1624.

1618. He lessens the personal services required of the natives. By careful instruction to the ships from Acapulco he enables them to avoid falling into the hands of the Dutch.

1619. Inauguration of the College of Santo Tomas.

1620. Combat in San Bernardino Straits between three Spanish and three Dutch vessels. Father Moraga, who had obtained from Philip III promises not to abandon the Philippines, as some of his advisers counseled him, perishes in a shipwreck.

1621. Arrival of Franciscan monks to found the Monastery of Santa Clara. Uprisings in Bohol and Leyte quelled by Don Juan de Alcarazo.

1623. Two expeditions against the Igorrotes.

1624. Cerciorado Fajardo, whose wife was unfaithful to him, kills her with her own dagger.

INTERREGNUM. DON GERONIMO DE SILVA (IN CHARGE OF MILITARY AFFAIRS); THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1624-1625.

1624. Victory won by Don Geronimo de Silva over seven Dutch vessels off Corregidor. Instead of pursuing his scattered enemy, he orders his fleet to return to Cavite, on account of which he is proceeded against and shut up in Fort Santiago.

DON FERNANDO DE SILVA (PRO TEM.)

1625-3626.

1625. Don Fernando accepts acquittal at the hands of his predecessor, and is put at liberty. Piratical expeditions from Borneo infest the coasts of Samar and other islands, doing great harm. The small fleet from Iloilo follows them, and failing to overtake them on the sea, goes to their country and punishes them.

1626. Expedition to Formosa. Tanchuy is occupied. The spread of Catholicism there.

DON JUAN NINO DE TAVORA.

1626-1632.

1626. This governor brings the image of the Virgin, which is worshipped at Antipolo.

1627. A strong armada sets forth under the orders of the governor for Formosa. Bad weather compels it to return to Manila, but the ship *Rosario* arrives at Tanchuy. The Dutch attack this port and are defeated. The alcalde of Cebu, Don Cristobal de Lugo, goes to Jolo, and afterwards to Basilan, in order to punish the Moros for piracy. His expedition results well.

1628. Plague at Manila. Sacreligious robbery at the cathedral. Destruction of the Church of the Company of Jesus. Expedition under command of Olaso against Jolo with little results.

1629. Great conflagration at Cavite.

1630. More fortunate expedition of Don Pedro Tonsino, commander of Dapitan, against Jolo. Arrival of the ambassadors of Camboja, offering free trade and a shipyard for the construction of vessels.

1631. The Jesuits establish the residence of Dapitan in Mindanao. The construction of a stone bridge across the Pasig.

INTERREGNUM. DON LORENZO DE OLASO (IN CHARGE OF MILITARY AFFAIRS): THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1632-1633.

1632. Foundation of the College of Santa Isabela for girl orphans of Spanish birth.

DON JUAN CEREZO DE SALAMANCA (PRO TEM.).

1633-1635.

1633. During the reign of this governor the archipelago is afflicted by various calamities, such as bad crops, famine, epidemics, a plague of locusts, volcanic eruptions, and Moro piratical expeditions.

1634. Moro pirates to the number of 15,000 lay waste the Visayan Islands, and sack the capital of Tayabas in Luzon.

1635. Foundation of the fort of Zamboanga to hold in check the piracy of the Moros. The fort is constructed under the direction of the Jesuit engineer, Father Malchor de Vera.

DON SEBASTIAN HURTADO DE CORCUERA.

1635-1644.

1635. Serious dissensions between the Archbishop Fr. Hernando Guerrero and the governor.

1636. Said misunderstandings are amicably adjusted. The pirate Tagal, on his return from his excursions among the islands, laden down with booty, is overtaken at Punta Fleches by the little fleet from Zamboanga, under command of Don Nicolas Gonzalez, who wins a complete victory. Three hundred Moros lose their lives, Tagal among them, and many captives are rescued.

1637. Corcuera goes to Mindanao and destroys Lamitan, the seat of government of Sultan Corralat, and attacks a formidable hill, which was his last defense. The Moros of Buhayen and Basilan sue for peace, and render homage to Spain.

1638. Corcuera arrives at Jolo. Obstinate resistance of the inhabitants of that island. They are finally overcome. Corcuera returns to Manila, after leaving at Jolo a garrison of soldiers and establishing a Jesuit mission. He enters in triumph with the booty captured from the Moros. Establishment of a number of outposts on Mindanao.

1639. Uprising of the Chinese at Calamba. Their forays against San Pedro Macate, Taytay, and Antipolo, and their ultimate defeat and submission. Establishment of the royal chapel. Foundation of the College of San Juan de Letran under the Dominicans. Don Francisco de Atienza conquers the Moros of Lanao, and takes possession of the celebrated lake bearing this name. In the combats with the Moros of Lake Lanao Friar Pedro de San Augustin distinguishes himself by his bravery and is called the "Father Captain." Victories of Don Pedro de Almonte over the Moros in Mindanao and Jolo.

1640. Separation of the Kingdom of Portugal from the Crown of Spain, which causes the Dutch to become more audacious. The Dominican fathers take charge of the College of San Juan de Letran.

1641. Three volcanoes burst forth, one in Jolo, another in Sanguil, in the southern part of Mindanao, and a third in Aringay, in the north of Luzon. Establishment of the royal college of San Felipe, which is promptly closed. Monks of the order of San Juan de Dios arrive.

1642. The Dutch attack the fort of Tanchuy in Formosa. The Spanish garrison, lacking help, surrenders with the honors of war and returns to Manila. As a precaution against an attack by the Dutch, Corcuera repairs the walls of Manila, mounts cannon upon them, gets together a large quantity of munitions of war, clears the field for military operations, destroying buildings, and makes similar preparations in Cavite.

1644 After a governorship of nine years, during which he carried out extensive undertakings, he leaves in the treasury half a million dollars.

DON DIEGO FAJARDO.

1644-1653.

1644. Don Diego Fajardo allows himself to be dominated by his favorite Venegas. Fajardo takes his predecessor Corcuera and shuts him up in Fort Santiago where he remains five years, being pardoned by the council of the Indes, and rewarded by the King with the post of governor of the Canary Islands.

1645. Frightful earthquake at Manila, called the earthquake of San Andres, on account of having occurred on this day. Manila is depopulated because the earthquakes follow each other at intervals of five days. The victims number 600. Peace is established with Corralat through the mediation of the Jesuit

Father Alejandro Lopez. The Dutch summoned by the Jolo natives attack the Spanish fort at Jolo and Ugalde, which splendidly repulses them. Bull of Innocencio X creating the University of Santo Tomas.

1646. The Spanish troops retire from Jolo after the Sultan has signed a treaty very honorable for the Spanish, through the mediation the above-mentioned Father Lopez.

1646. Don Lorenzo de Ugarte defeats at Bolinao a powerful Dutch squadron. Three other victories are obtained over Dutch ships.

1647. Thirteen Dutch galleons attack Cavite. It is defended by Don Andres de Asaldegui until the Dutch admiral is mortally wounded and his vessels retire. The Dutch disembark at Abucay and seize the defenseless town, committing abuses there until they reembark, pursued by Don Juan de Chaves.

1648. Victory of the little squadron from Zamboanga over the Jolo squadron; the Moro prince, Paquian Cachile, being wounded and taken prisoner.

1641. Successful expedition to Borneo to punish the pirates of that island. Uprising of the Visayans under a pretext of an order of Fajardo compelling them to go to Cavite to aid the Tagalogs in the construction of ships.

1651. Fajardo comes to understand the intrigues and disturbance brought about by his favorite Venegas. The latter is confined and his property is confiscated.

1653. By royal decree the college of San Jose is given precedence over Santo Tomas.

DON SABINIANO MANRIQUE DE LARA

1653-1663.

1654. The cathedral having been ruined by earthquakes, the first stone of the new one is laid.

1655. Corrolat, Sultan of Mindanao, breaks the treaty of peace and uses his nephew to bring about the assassination of the Jesuit Fathers Alejandro Lopez and Juan de Montiel, who had gone to Buhayen as ambassadors. Loss of various ships.

1656. Famine and misery in the islands as a result of a great plague of locusts. Balatamay, nephew of Corrolat, engages in piracy in the Visayan Islands.

1657. The governor of Zamboanga pursues the pirate Balatamay, and not finding him on the sea goes to his country and destroys a number of Moro towns.

1658. A great earthquake.

1660. Uprising in the provinces of Pampanga and Pangasinan. It is quelled without bloodshed.

1662. The Chinese pirate Koseng demands the submission of the archipelago, with serious threats. Reply of Manrique de Lara to the insolent demands of the pirate. In order to provide against the attack of Koseng, select bodies of infantry are formed. A squadron of cavalry is organized, churches, conventos, and houses outside the walls are thrown down; the governor, the monks, and the people of the neighborhood contribute in order to raise funds. Uprising of the Chinese in the suburbs of Manila and their subsequent submission.

1663. Koseng dies, and his son, listening to the advice of Father Ricci, a Dominican, desists from his preparation for war, and sends the above-mentioned father as an ambassador to arrange commercial treaties.

1663. In order to concentrate the Spanish forces the garrison of Zamboanga retires and the Moros resume their piratical expedition.

DON DIEGO DE SALCEDO.

1663-1668.

1664. The governor provides for the regular departure of ships for Acapulco, and establishes shipyards in the provinces where it is easiest to obtain timber. Embassies are sent in the interest of commerce to Camboja, Siam, and Batavia. The governor quarrels with the municipality, with the archbishop, and with the chaplain of the cathedral needlessly.

1667. Death of the Archbishop Poolete as a result of the disrespect of the young governor. Expedition to subdue the Igorrotes.

1668. Father Paternina, an Augustinian commissioner of the holy office, imprisons the governor. Evangelization of the Marianas Islands. School established for boys at Guajan in charge of the Jesuits.

DON JUAN MANUEL DE LA PENA BONIFAZ (PRO TEM.).

1668-1669.

Bonifaz gains friends, and in order to do it increases the salary of the soldiers so that he leaves the royal treasury well nigh exhausted.

DON MANUAL DE LEON.

1669-1677.

1669. Embassy of Don Juan Enriquez de Lozada, and Jesuit Father Francisco de Mecina to Macao. These gentlemen bring it about not only that commerce is reestablished with Macao, but also that it is established with Canton and Ningpo. Commerce with Coromandel and Siam is favored. The ex-Governor Salcedo is sent on shipboard and dies before reaching Mexico.

1671. The ship *Buen Socorro* from Acapulco arrives with $150,000. The bay of Manila is covered by numerous vessels and commerce is very active. Leon interferes in ecclesiastical affairs, annulling the election of the provincial of the Augustinians, and ordering them to remain shut in until they elect a new provincial. He persecutes the Franciscan Father Solier.

1672. Father Peternino is sent as a convict to Mexico, and dies on the way at the same latitude south at which Salcedo died. The Bishop of Herapolis, an apostolic vicar, arrives at Manila on the way to Siam. The governor detains him and sends him again to Europe, a course which was condemned at Madrid and in Rome. The Jesuit Father Sanvitores suffers martyrdom in the Marianas Islands.

1673. Competition between the governor and the archbishop, whom the former deprives of his stipends.
1674. The archbishop dies. There is no consecrated bishop in the islands until 1680. During this time candidates for holy orders are sent to Mexico or to Siam.

INTERREGNUM. DON FRANCISCO COLOMA AND AFTERWARDS DON FRANCISCO SOTOMAYOR MANSILLA (IN CHARGE OF MILITARY AFFAIRS); THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1677-1678.

After commanding for five months Coloma dies and is succeeded by Mansilla. During his governorship the Church of the Third Order of San Francisco is constructed. The religious communities make out to extend Catholicism in China, Japan, and Siam. Earthquakes frequent, although not very strong.

DON JUAN DE VARGAS HURTADO.

1678-1684.

1678. This governor encourages the development of commerce.
1679. Don Fernando de Valenzuela arrives, exiled to these islands; he had been the first minister of Carlos II.
1683. After various rivalries between the Archbishop Cabildo, the royal audiencia, and other corporations, Vargas exiles to Pangasinan the Archbishop Don Fr. Felipe Pardo, as the royal audiencia had already decreed several months before.

DON GABRIEL CURUZELAEGUI.

1684-1685.

1684. The governor desires to terminate the discords which have occurred during the governorship of his predecessor. He revokes the sentence of banishment against Archbishop Pardo, but far from quieting animosities, they are further enkindled by arbitrary measures against Vargas and his friend.
1685. An epidemic of smallpox causes great mortality.
1686. The loss of crops on account of superabundant rainfall.
1687. A conflagration destroys the greater part of the suburbs of Baybay and Tondo.
1688. Don Francisco de Campos Valdivia arrives at Manila, empowered to take action in the matter of the punishment of Archbishop Pardo. Valdivia restores the royal audiencia, which had been destroyed, together with the prison of Oidores.

DON ALONZO FUERTES (IN CHARGE OF MILITARY AFFAIRS); THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1689-1690.

Fuertes maintains public quiet and holds in check the troublesome spirit. He embarks for Spain at Valdivia.

DON FAUSTO CRUZAT.

1690-1701.

This governor takes great pains to swell the public funds, collecting what various private individuals owed the treasury and lowering the salaries of various employees. The construction of a number of edifices, such as the royal audiencia, the auditor's office, the prison of Corte, and the beginning of the royal storehouses.

1693. The ship *Santo Cristo de Burgos* is lost.

1694. The galleon *San Jose* is lost and 400 people perish.

1696. The governor publishes the ordinances of good government.

1697. The Franciscan brother Javier, learned in marine matters, begins with Father Prado (both of them Jesuits) a journey to the Marianas Islands in search of the Caroline Islands, but the vessel sinks and the brother returns to Manila.

DON DOMINGO ZABALBURU.

1701-1709.

During his governorship Zabalburu concludes the work upon the royal storehouses, reconstructs the royal powder house of Malate, repairs the fortifications of Cavite, and attends to the construction of galleons. Commerce is in a flourishing condition.

1704. The patriarch of Antioch, Señor Tournon, with the title of Pope's legate a latere, arrives at Manila on the way to China. This gentleman does not make suitable response to the kindly reception given him, but takes advantage of the dissension of the governor and the archbishop and causes serious trouble. The galleon *Rosario*, under command of Don Fermin de Salaveria, has a combat with two English ships of war, which were compelled to retire, one of them afterwards being lost. The Sultan of Jolo visits the Sultan of Mindanao; on account of supposed offenses they come to blows, with the result that both are killed. The nephew of the deceased Sultan of Mindanao asks help of Zabalburu, who pacifies the Moros through the Jesuit Father Borja.

1705. Wreck of the galleon *San Javier*, commanded by Don Santiago Zabalburu, brother of the governor.

1706. Death of the Jesuit Father Juan Davila, who introduces into the Philippines the cultivation of cacao, which he brought from Mexico. The archbishop of Manila, Señor Camacho, having fallen into disgrace with King Philip V on account of the dissension of this prelate Señor Tournon is transferred to the bishopric of Guadalajara, in Mexico.

1708. Fruitless expedition in search of the Caroline Islands.

1709. Another expedition in search of the Caroline Islands is frustrated by thick weather. Destitution of Governor Zabalburu because his dissension with Señor Tournon has displeased King Philip V.

CHAPTER III.

THIRD PERIOD—FROM THE DISMISSAL OF GOVERNOR ZABÁLBURU (1709) TO THE TAKING OF MANILA BY THE ENGLISH (1762).

DON MARTIN URZUA.

1709-1715.

1709. This governor causes all Chinamen above a certain number to return to their country.

1710. On the coast of California the ship *Nuestra Señora*, commanded by Don Fernando Angulo, defends itself against three English vessels, obliging them to retire. An expedition leaves Cavite for the Carolines. The Jesuit Fathers Duberon and Cortil disembark in Sonsorol and again reembark on account of currents.

1712. Another expedition to the Carolines suffers shipwreck. The Dominicans return to the Recoletos the administration of the province of Zambales.

INTERREGNUM. DON JOSE TORRALBA (IN CHARGE OF MILITARY AFFAIRS). THE ROYAL AUDIENCIA (IN CHARGE OF CIVIL AFFAIRS).

1715-1717.

Torralba orders the casting of much artillery of heavy caliber; he also orders the perfection of work on the royal storehouses and the construction of a bastion in connection with said storehouses. This governor permits certain arbitrary acts, which cause him to forfeit the good will of the public.

DON FERNANDO DE BUSTAMANTE.

1717-1719.

1717. This governor takes great interest in collecting the sums due the royal treasury and gets together in a single year more than $300,000.

1718. Reestablishment of the presidio of Zamboanga. Construction of a presidio at Labo, in the southern part of Palawan. Bustamante sends his nephew as ambassador to the King of Siam in order to arrange treaty of commerce. The previous temporary governor, Torralba, accused of a heavy embezzlement, is imprisoned. Bustamante, on account of his harsh character, makes enemies of everyone.

1719. The governor, upon learning that a conspiracy is being formed against him, in which the municipal authorities are taking part, commits all sorts of abuses. Rebellion breaks out, and the mob assassinates Bustamante and his son.

INTERREGNUM. THE ARCHBISHOP DON FR. FRANCISCO DE LA CUESTA.

1719-1721.

1719. No one wishes to take charge of the government. The unanimous wish of the people in Manila and vicinity is that the archbishop take charge. After his objection to it he finally accepts the post in order to avoid unhappy consequences. He arranges for the solemn interment of the deceased governor. Sets aside $1,000 monthly for the maintenance of his six sons until they can be sent to Mexico. Reestablishes the royal audiencia and takes summary measures against the promoters and perpetrators of the assassination of Bustamante.

1720. Five thousand Moros besieged Zamboanga for two months. The governor, Don Sebastian Amorrea, performs prodigies of valor and saves the city. The council of war decrees the abandonment of the presidio at Labo.

DON TORIBIO JOSE DE COSIO, MARQUES DE TORRE CAMPO.

1721-1729.

1721. Gen. Antonio Rojas pursues the Moro pirates without result.

1723. Another little squadron under command of Don Andres Garcia Fernandez, but the Moros grow bolder and bolder. Don Juan de Mesa directs a new expedition against them, recovers the *Sabanilla*, and causes the death of many, among them several chiefs.

1724. Archbishop Cuesta, the governor pro tempore of the Philippines, dies at Mechoaran, in Mexico, to which place he had been sent by the King.

1725. The Sultan of Zulu sends to Manila a Chinaman named Kikan, in order to sue for peace.

1726. There is signed at Zulu an agreement between the Sultan and Spain, and the Moros immediately violate the agreement, beginning their piratical operations again. The Recoleto Fr. Benito de San Jose defends very bravely the town of Cateel, defeating there the Moros, but dies of the wounds which he receives. Seventy embarkations manned by Chinese pirates are overtaken and completely destroyed by our armada. The galleon *Santo Cristo de Burgos* is lost, the crew being saved.

DON FERNANDO VALDES.

1729-1739.

1729. Valdes repairs the fortifications and provides armaments for the plaza.

1730. A fleet of 20 vessels manned by 3,000 Sulu pirates causes great damage among the islands of the south and attacks Taytay, which Don Pedro Lucena successfully defends. The Jesuit Father Contova goes to the Carolines, where he arrives the following year, and later suffers martyrdom.

1731. A strong squadron sails from Cavite to Sulu and punishes the Moros, burning towns, ravaging the fields, and killing many individuals. The Sultan of Tamontaca asks aid of the Spaniards against Prince Malinog, the ally of the Dutch. Assistance is furnished him and a great victory is achieved.

1733. A conflagration destroys the royal storehouses at a time when they were quite sufficient to the public needs.

1734. Fruitless expedition is sent in aid of the Sultan of Tamontaca. The Moros attempt to surprise the presidio of Zamboanga, but are repulsed.

1735. Two thousand Moros attack Taytay. Brilliant defense of this town by Cienfuegos aided by three monks. Three large Dutch war ships anchor in the bay of Manila demanding a vessel of their nation which has been made a prize by Don Francisco Muñez in the waters near Mindanao, and an agreement is reached with them. There arrives a royal cedula which settles in favor of the commerce of Manila the vexatious question of the introduction into America of silks from China.

1737. Don Juan Gonzalez del Pulgar is sent to Sulu to ratify a compact of peace with the new ruler of that island. Archbishop Don Fr. Juan Argel Rodriguez arrives at Manila. He belongs to the order La Mercid. He arranges support for the chorus, orders Gregorian chanting, and wins the good will of the authorities and the people.

DON GASPAR DE LA TORRE.

1739-1745.

1740. Three Moro vessels attack a native boat and take prisoner Fr. Hipolito de San Augustin, a Recoleto. He is taken to Sulu. The Sultan asks a ransom of $2,000, but the rector of the Jesuits of Zamboanga finally arranges the matter for $1,000.

1741. The governor makes arrangements for the defense of the coast and the pursuit of the Moro pirates.

1742. The English Admiral Ansón captures the ship *Covadonga* which was on the voyage from Acapulco.

1743. A squadron sets forth in pursuit of Ansón, but does not find him and returns.

1745. Insurrection in Batangas. General Juan Gonzalez del Pulgar is sent to quell it.

INTERREGNUM. DON FR. JUAN DE ARRECHEDERRA, A DOMINICAN, BISHOP-ELECT OF NUEVA SEGOVIA.

1745-1750.

1745. The bishop-governor with great activity and zeal undertakes fortifications to defend the plazas, orders the casting of cannon of caliber 18, provides a suitable amount of munitions of war in the Governor's storehouses and authorizes Dom Geronimo Itta Salazar to arm his tender the *Santo Domingo*.

1746. In defiance of a royal prohibition which is very harmful to business, the ships *Rosario* and *Pilar* prepare to sail for Acapulco. The Governor of Zamboanga orders that each year an expedition be sent against the pirates.

1747. Two Dutch ships make a futile attempt to take possession of Basilan.

1749. Ali-Mudin, Sultan of Sulu, arrives at Manila, asking to be placed again upon his throne, which he says has been usurped by Bantilan.

1750. Ali-Mudin receives baptism, although there are some who do not believe in his conversion.

DON FRANCISCO JOSE DE OBANDO

1750-1754.

1750. The piracy of the Moros continues with the aid of Bantilan.

1751. A squadron sets sail in order to place Ali-Mudin again upon the throne of Sulu under the name of Fernando I. While the latter remains at Basilan, the squadron goes to Sulu, and later to Zamboanga. The treachery of Ali-Mudin is revealed by a letter from him to the Sultan of Tamontaca. He is sent a prisoner to Manila.

1752. Expedition to Sulu with little result. An expedition sent to take possession of Palawan is obliged to return to Manila because its members fall sick. Two thousand Moros besiege Iligan, and Father Ducos, a Jesuit, defends the plaza and defeats the Moros.

1754. All the ocean regions of the archipelago are invaded by Moro pirates, who carry terror and misfortue wherever they land. This is the worst piratical movement on the part of the Moros up to the date indicated. A squadron under command of Don Miguel Gomez Valdes sets forth in pursuit of them.

DON PEDRO MANUEL DE ARANDIA

1754-1759.

1754. The governor reorganizes the militia, augments the salaries of the army men, changes the uniform, creates what is called the King's Regiment and four brigades of artillery, and establishes artillery schools. He puts in order the arsenal and storehouses of Cavite and the ship from Acapulco. A terrible eruption of Taal attended with sad results. A plague arises, produced by the multitude of fishes killed by the eruption, which float upon Taal Lake. Father Ducos takes command of the fleet off Iligan, and directs it so well that it destroys 150 hostile boats and kills 3,000 Moros.

1755. Arandia expels the Chinese pagans, and constructs an alcayceria, where Chinese who come to engage in trade are obliged to reside temporarily. Chinese who have accepted Christianity are permitted to remain in the islands, but only for the purpose of tilling the soil, being prohibited from engaging in business. A presidio is constructed at Misamis under the direction of Father Ducos, who also repairs the fort of Tandag. An expedition under command of Don Pedro Zacarias Villareal goes to Sulu, where peace is announced between Bantilan and the Spaniards, but once more the Moros break their agreement.

1756. Don Pedro Gaztambide wins a great victory over thirty-eight piratical vessels off the coast of Batangas.

INTERREGNUM. DON MIGUEL LINO EZPELETA, BISHOP OF CEBU.

1759-1761.

1759. Archbishop Don Manuel Rojo arrives at Manila. He aspires to the governorship of the islands, which belongs to him, but Ezpeleta refuses to give up the post. He makes a prisoner of Orendain, the favorite of the former governor, and from this there arises a suit which his successor terminates.

(Interregnum).

DON MIGUEL ROJO, ARCHBISHOP OF MANILA.

1761-1762.

1761. Rojo takes command by virtue of a royal cedula which he receives; he shows himself kindly disposed toward Ali-Mudin, whom he wishes to place again upon the throne of Sulu.

1762. An English squadron of thirteen ships, with more than 6,000 men, under command of Admiral Cornish, and of Brigadier Draper, arrives at Manila, which is unprepared to resist attack. Treacherous conduct of the Frenchman Fallet, and of the Spanish-American Orendian. Weakness of Archbishop Rojó.

CHAPTER IV.

FOURTH PERIOD—FROM THE TAKING OF MANILA BY THE ENGLISH (1762), TO SEDITION OF TAYABAS, (1841).

DON SIMON DE ANDA SALAZAR.

1762-1764.

1762. The junta of authorities names Anda governor; he leaves Manila and goes to Bulacan. Capture and sacking of Manila by the English. Anda makes himself known in Bulacan as governor and prepares for the defense of the country, with the aid of the monks. Uprisings in the provinces.

1763. Expedition of the English to Bulacan. Asturian Bustos harasses the English, who retire to Manila, after burning the convent and church of Bulacan. Bustos establishes his general headquarters at Malinta, from which place he makes forays, even to the suburbs of Manila. Provisions grow scarce in the latter city.

1764. Archbishop Rojo dies. Anda receives dispatches from the King informing him of the treaty of peace with the English. The new Spanish governor arrives, to whom Anda turns over the governorship of Pampanga. Triumphal entry of Don Simon de Anda into Manila after the evacuation by the English.

(Interregnum).

DON FRANCISCO DE LA TORRE.

1764-1765.

La Torre makes good, so far as possible, the injuries which war has inflicted on the country.

DON JOSE RAON.

1765-1770.

1765. The war frigate *Buen Consejo* comes to the Philippines by way of the Cape of Good Hope, thus inaugurating direct communication between Spain and the Philippines. Two eruptions of the volcano Mayon.
1767. A Moro piratical expedition enters the Bay of Manila.
1768. The Jesuits are expelled from the Philippines by order of Carlos III. The towns which have been under their charge show regret.
1769. It is ordered that the Chinese be expelled from the Philippines, but this order is only partially fulfilled.

DON SIMON DE ANDA SALAZAR.

1770-1776.

1770. Anda repairs the walls of Manila and within a few months brings about the construction of several war vessels.
1771. Provincial council (of bishops?) of Manila.
1773. The frigate *Deseada* is dispatched to Batavia to reestablish business relations.
1774. Shameful conduct of the Italian Cencelly, to whom Anda has intrusted the command of a squadron.
1775. The Moros assassinate the garrison left by the English in the island of Balambangan.
(Interregnum.)

DON PEDRO SARRIO.

1776-1778.

Sarrio provides a little fleet of light boats to pursue the pirates, and obtains good results.

1778. Ismael, the Sultan of Sulu, is poisoned by the partisans of the sons of Bintilan.

DON JOSE BASCO Y VARGAS.

1778-1787.

Basco during his governorship shows a decided desire to develop agriculture. He obtains seeds from other countries, and causes more than 4,000 mulberry trees to be planted in Camarines Sur for feeding silkworms.

1778. In a short time Basco rids the country of evil doers. Don Jose Gomez combats piracy with good results, distinguishing himself in pursuit of the pirates; eventually he dislodges them from Mamburao, in the island of Mindoro, where they had established forts. The order for the expulsion of the Chinese is revoked.

1779. Basco grants rewards to those who are conspicuous for their success in agriculture.

1781. The Sultan of Sulu sues for peace and returns a captured vessel. Establishment of the Economical Society of Friends of the Country.

1782. The tobacco monopoly is established, and as a result the public funds are considerably increased. Successful expeditions of Don Jose Gomez to Burias.

1783. Preaching of the faith in the Batanes Islands, which Basco annexed to the Crown of Spain.

1785. The King authorizes the creation of the Royal Company of the Philippines.

1786. Royal order approving the establishment of the powder magazine.

(Interregnum.)

DON PEDRO SARRIO (FOR THE SECOND TERM).

1787-1788.

The Ilocanes revolt on account of the tobacco monopoly, but afterwards submit again. Sarrio proves that it costs $101,300 annually to maintain the forts and fleets of the Visayan Islands and Mindanao.

DON FELIX BERENGUER DE MARQUINA.

1788-1793.

It is provided that the appointment of the cabezas de barangay be made by the provincial chiefs, on the nomination of the headmen of the town.

1790. Marquina submits a "plan of reform," which, in his judgment, ought to be made in the Philippines, and approves of "instructions" which tobacconists must observe in regard to the tax on wines.

1792. Don Antonio Pineda dies in Ilocos. He was commissioned by the Government to study the flora of the Philippines.

DON RAFAEL MARIA DE AGUILAR.

1793-1806.

On account of the war with England, he reenforced the fortifications, augments the navy, establishes a dockyard at Corregidor, and puts 10,000 men under arms.

1794. A bastion is constructed in Binondo which dominates La Barraca.

1796. The ships *San Pedro*, *Montanes*, and *Europa*, and the frigates *Fama* and *Pilar*, under command of Don Ignacio Maria de Alava, who becomes chief of the squadron, which is composed of the above-mentioned vessels, and in addition of three frigates which have previously arrived. By royal order the transfer of the bastion of San Blas de California to Cavite is provided for. Creation of the grenadier regiment of Luzon and Batangas and of five battalions of militia. Great earthquake.

1797. The squadron under command of Alava sails in pursuit of an English convoy, but encounters a typhoon, but within a year the injuries which the ships received are repaired. Loss of the *San Andres* on the coast of Albay.

1798. An English squadron flying a Spanish flag arrives at Zamboanga and the governor, Don Raymundo Español, defeats the enemy and saves the plaza. The Moros attack Baler, Casiguran, and Palanan.

1799. Order for a definite census of the natives. Order prohibiting the secretion of fractional silver currency. The frigate *Pilar* arrives with $1,200,000, thus relieving the financial difficulties.

1800. The marine comandancia is created. Foreigners are prohibited from living in the Philippines.

1801. Raon's "Ordinances of Good Government" are suppressed.

1802. The bastion called La Barraca is done away with.

1803. A magistrate is sent to Mindoro in order to promote the development of the island. The English again take possession of the island of Balambangan.

1805. The English again attack Zamboanga and are defeated. Sainte-Croir is commissioned to investigate the gold mines of Mandulao in Camarines, and later publishes his report. The complete independence of the Manila custom-house is decreed by royal order.

1806. The English abandon Balambangan. Creation of two divisions of marine grenadiers, each numbering 150 men.

INTERREGNUM. DON MARIANO FERNANDEZ DE FOLGUERAS.

1806-1810.

1806. Folgueras takes precautions against a possible attack upon Manila by the English.

1807. Uprising in North Ilocos, which is subdued chiefly by the monks.

1808. The order of Santo Domingo favors the Company of the Philippines with a loan.

1809. The brigantine *Activo* arrives at Manila, bringing news of occurrences in Spain. The French sloop of war *Mosca* attacks Batangas and the parish priest at the head of the natives repels the sloop.

DON MANUEL GONZALEZ AGUILAR.

1810-1813.

1810. Aguilar proposes the suppression of ships to Acapulco and to concede to merchants the right to fit out private ships for voyages to America.

1811. Publication of the first newspaper in the Philippines, with this beginning Del Superior Gobierno. Uprising of some fanatics who proposed to found a new religion.

1812. The religious orders contribute money to save the situation in which the Philippines are found. Fr. Julian Bermeho, parish priest of Boljoon, in Cebu, obtains several triumphs over the piratical Moros.

1813. The constitution of 1812 is published in Manila.

DON JOSE DE GARDOQUI JARAVEITIA.

1813-1816.

1813. By the decrees of the Cortes the ship to Acapulco is suspended. The last one starts in 1811 and returns in 1815. The Moros attempt in vain to take Zamboanga. Gardoqui encourages agriculture.

1814. Movements originate in the Philippines for the publication and revocation of the constitution of Cadiz. In Laoag Father Vicente Febro, the Augustin parish priest, founded at their expense a hospital for lepers, which is the first establishment of this kind in the Philippines. The English shrewdly attempt to take possession of Jolo and Mindanao. The introduction of opium is prohibited. Great eruption of the volcano of Mayon.

1815. By royal order the apostadero de marina (shipyard) is suppressed. (Interregnum.)

DON MARIANO FERNANDEZ DE FOLGUERAS.

1816-1822.

1817. Expedition of Fr. Juan Prieto to the country of the savage Mayoyaos. A royal order decrees that in the convents of monks and nuns there shall be established schools for boys and girls.

1818. Naval victory over the pirates on the coast of Albay obtained by Don Pedro Esteban. Restoration of the fortifications of Zamboanga.

1819. Reestablishment of the Royal Economic Society of the Philippines.

1820. Royal cedula, according to which there is conceded the suppression of duties during ten years on natural and industrial products of the Philippines imported into the Peninsula in ships flying the flag. Cholera in Manila. All authorities and religious orders literally pray to heaven to combat this sickness. There is prevalent among the natives a belief that the foreigners have poisoned the waters. The mob assassinates the English and French residents in Manila to the number of 28; afterwards they attack the Chinese.

1821. The constitution of 1812 is again sworn to in Manila. Creation of the Naval Academy.

DON JUAN ANTONIO MARTINEZ.

1822-1825.

1822. With Martinez many officials from the Peninsula come to the Philippines, following the counsel which had been given to Folgueras, because those already there were almost all Spanish-Americans. Martinez sends to Spain various persons who, it is said, were in conspiracy. Captain Novales provoked an uprising in which Don Mariano Fernandez Folgueras is traitorously assassinated, but it is promptly suppressed by the local authorities. The padre provincial of the Recoletos, with others of the religious order, are captured by the Moros and held in $10,000 ransom.

1824. Strong earthquake in Manila. The statue of Carlos IV is placed in the Plaza de la Palacio. Fortunate expeditions under command of Don Alonso Morgado against the pirates, who are punished and suffer great loss.

DON MARIANO RICAFORT.

1825-1830.

1825. Ricafort brings a painting of Fernando VII, and there is given to it the reception which would have been given to the royal person if he had come to these islands. The governor issues orders to encourage agriculture.

1826. By royal order the religious orders again take charge of certain parishes which had been given to the secular clergy.

1827. The reestablishment of the dockyard is decreed. An expedition to suppress the rebellion in Bohol.

1828. Ricafort prohibits strangers from going into the provinces to acquire products of the country. The royal order commands the protection and cultivation of cotton and the introduction of machinery for making thread and cloth of said article. Royal order commands the establishment of a mint in Manila. Earthquake in Manila.

1829. It is ordered that a reformation be made in the general management of the Chinese resident in these islands.

1830. The arrival in Manila of the expeditionary regiment of Asia in consequence of a request by Ricafort to Spain for European troops, and the reorganization of the regiment of the King.

DON PASCUAL ENRILE Y ALCEDO.

1830-1835.

Enrile makes a general map of the archipelago, profiting by the knowledge acquired in expeditions which he had made before being nominated governor. He causes roadways and smaller paths to be made connecting with these, and puts up several bridges.

1830. By royal order the eight districts fronting the Moros are declared military and political penal districts.

1832. By royal order the commercial code promulgated in Spain is extended to the Philippines with such variations in its application as the archipelago requires.
1833. Royal order in regard to the control of pious works.
1834. Enrile causes the publication of "La Guia de Forasteros" with interesting notices.
1835. The board of trade is organized.

DON GABRIEL DE TORRES.

1835.

Presides at a meeting for the election of deputies to the Cortes. Dies after being fifty days in office.

INTERREGNUM DON JOAQUIN DE CRAMER.

1835.

Cramer issues a decree in regard to the government of the archipelago. Officers of the veteran army are placed as commanders of the provincial militia.

INTERREGNUM DON PEDRO ANTONIO SALAZAR.

1835-1837.

1835. There is established a gradual impost by stamps on bills of exchange.
1836. Salazar decrees that simple pesetas shall have in these islands the value of 4 reales, as they have in the Peninsula, and not of 5 reales, as they have in this archipelago. A treaty of commerce is signed with the Sultan of Jolo.
1837. A department of inspection of mines is organized in these islands.

DON ANDRES MARIA CAMBA.

1837-1838.

1837. Camba declares to the government that the plans adopted of making peace and alliance with the Sultan of Jolo does not bring a single decided advantage to navigation or to commerce. Father Manuel Blanco, Agustin Fr., publishes La Flora de Filipinas.
1838. The post-office department begins its work according to the reforms published the year before. There is created in Spain a consulting committee for the business of the colonies.

DON LUIS LARDIZABAL.

1838-1841.

1839. Lardizabal, who is a Visayan, gives the name of Nueva Viscaya to a new province which is formed from the province of Cagayan. Increases also by one section the grenadiers, and publishes certain orders in regard to the government and taxation of the Chinese. Recognizing the excellent quality of Philippine tobacco and at the same time the defective methods of manufacture, he takes measures to prevent adulterations. There is published in Manila a weekly paper entitled Current Prices of Manila.

1840. Inauguration of School of Commerce. Some orders are made in regard to the rightful censorship of books. There is created a committee for the control of manufactures and a general administration of taxes. Lardizabal submits to the Supreme Government a project for a monument to Magellan, in the island of Mactan.

CHAPTER V.

FIFTH PERIOD—FROM THE SEDITION OF TAYABAS (1841) TO THE GOVERNMENT OF DON DIEGO DE LOS RIOS, LAST SPANISH GOVERNOR-GENERAL IN THE PHILIPPINE ISLANDS (1899).

DON MARCELINO DE ORAA.

1841-1843.

1841. Sedition in Tayabas promoted by a certain Apolinario de la Cruz, called by his fanatical followers King of the Tagalos, and to whom they attribute supernatural powers. Commandant Huet completely overthrows these rebels. There is created by royal order the Gobierno Intendencia de Visayas, with its capital in Cebu.

1842. A circular recommending the discovery of coal mines. The publication of the order concerning the free construction of ships. The publication of the regulations for the control and policing of the bay and port of Manila.

1843. Uprising in Malate of a regiment composed of soldiers from the province of Tayabas, dominated and controlled with the aid of the local troops from Pampanga and Camarines. The establishment of a subdelegation of medicine and surgery.

DON FRANCISCO DE PAULO ALCALA.

1843-1844.

1843. The shipyard of Masbate is transferred to Cebu. Certain rules are published to the consignees of the Chinese Sampans in regard to unloading. Authorization to the Chinese to use opium, it being declared at the same time to be a monopoly.

1844. Takes possession of the island of Basilan to better control the Moros. The Indians and half-castes are prohibited the smoking of opium. Alcala regulates the offices of the treasury, organized the army, indicates the necessity of licenses for the use of arms, and publishes dispositions in regard to the affairs, passports, carriages, and other matters.

DON NARCISO CLAVERIA.

1844-1849.

1844. Claveria, with the consent of the ecclesiastical authority, reforms the calendar in the Philippines to conform to that of Spain and America, suppressing the 31st day of December, 1844; therefore the archipelago finds itself a day in advance. Commands the building of a fort in the island of Basilan, which was occupied by his predecessor. Orders that the alcaldes shall be educated. Prohibits the chiefs of provinces from engaging in commerce. The French attempted to take possession of the island of Basilan.

1845. Claveria starts to visit the provinces of Luzon.

1846. Claveria publishes rules for the development of mineral industries.

1847. A fire reduces to ashes the suburbs of Santa Cruz and Quiapo. An expedition is sent under the command of Don Mariano Oscariz to subdue the bloody savages of Mayoyaos, in Nueva Viscaya. Important conquest of Davao on the south of Mindanao by Don Jose de Oyanguren. A body of constables is created for public security against criminals. Political and military governors are prohibited from engaging in commerce.

1848. Claveria directs an expedition to the islands of Balanguingi; destroys completely the towns occupied by the pirates, with the death of many Moros and the rescue of 200 captives, several of these Dutch from Java. There are purchased in London the steamers *Magallanes*, *Elcano*, and *Reina de Castilla*, which are the first ships of this kind seen in the Philippines. Erection of the monument to Magellan in Manila.

1849. Claveria orders the change of names of the Indians of which there is little variety. The regular clergy are prohibited from transferring their property without previous royal license. The organization of bodies of police in the provinces. Creation of an academy of drawing and painting.

(Interregnum.)

DON ANTONIO BLANCO.

1849-1850.

Blanco forms a body of vaccinators, and obliges all children to be vaccinated. The province of Union, in the comandancia of Agno, is created. Monthly lottery is established in Manila.

DON ANTONIO DE URBIZTONDO.

1850-1853.

1850. The Moros from Jolo attack Samar and Camiguin. Urbiztondo grants permission to the planters to introduce Chinese, who are to devote themselves exclusively to agriculture. The governor-intendencia of the Visayas is suppressed.

1851. Urbiztondo himself directs an expedition to Jolo, destroying the forts and capturing 112 cannon, reducing to ashes the quays and a multitude of boats. The bravery and death of Padre Ibañez, a Recoleto, in the taking of Jolo. The tobacco from Cagayan, in the north of Luzon, is given a premium and gold medal at the Universal Exposition in London.

1852. Inauguration of the suspension bridge which unites Arroceros with Quiapo. The Spanish-Philippine Bank begins its operations. A prison is established in Polloc. The official bulletin of the Philippines is established. Various earthquakes are felt.

1853. Eruption of the volcano of Mayon.

(Interregnum.)

DON RAMON MONTERO.

1853-1854.

1854. On account of the inprudence of the governor of the island of Basilan a company of soldiers is assassinated by the Moros.

DON MIGUEL PAVIA Y LAY.

1854-1854.

During his brief administration of eight months he establishes a monthly mail between Manila and Hongkong. The uprising of one Cuesta, who soon falls into the hands of justice. Earthquake is felt in Manila. Razes the suburb of Tondo.

(Interregnum.)

DON RAMON MONTERO (SECOND TIME).

1854.

A multitude of royal orders arrive, relieving almost every official in the archipelago.

DON MANUEL CRESPO.

1854-1856.

1855. The tribunal of commerce is reestablished. Naval Officer Gonzales captures in the waters of Jolo a pirate boat, and soon afterwards, with Villaireencio, they destroy, at Balanguingui, a pirate fleet, which at that time was being constructed by the Moros. The name of the province of Manila is given to that which up to this date has been called Tondo. A cyclone causes great destruction. Eruption of the volcano Macaturang in Mandanao.

INTERREGNUM. DON RAMON MONTERO (THIRD TIME).

1856-1857.

1857. The clandestine introduction of immoral books with immoral pictures causes Montero to issue a decree to do away with this evil.

DON FERNANDO DE NORZAGARAY.

1857-1860.

1857. Norzagaray decrees that the official accounts shall be carried on in the decimal system. Authorizes the establishment of houses for the exchange of money. Publishes a very energetic decree against criminals.

1854. An expedition of 1,500 men, under the command of Col. Don Bernardo Ruiz, starts from Naila for Cochin China, to aid the French. Norzagaray establishes a politico-military government in the island of Balabac, on which the English were beginning to fix their attention. Publishes a proclamation for the defense of fishing towns, and sends an expedition under the command of Malcampo to Simisa, which is garrisoned by piratical Moros, and another under the command of Gonzales against the island of Pilas, causing in each great injury to the Moros and rescuing various captives. Beautifies Manila and its surroundings and organizes the botanical gardens.

1859. The Jesuits return to the Philippines with the object of doing missionary work in Mindanao, and at the petition of the governor and of the ayuntamiento by authority of the Government they take charge of the so-called "pious school." By royal order the commander of the navy in the Philippines is authorized to issue nominations to second and third mates. An ærolite falls in the town of Mexico, in Pampanga.

(Interregnum.)

DON RAMON M. SOLANO.

1860.

Creation of a civil government for the province of Manila. Foundation of the Maritime Mutual Benefit Society. Unveiling of a statue of bronze of Isabella II in Arroceros. Solano orders various improvements in the war department, among others the change of uniform for the army to one more suitable for the climate of this country. Orders the demolition of the "Parian," and accomplishes this in spite of a thousand difficulties. The market of Quinta is opened to the public.

(Interregnum.)

DON JUAN HERRERA DAVILA.

1860-1861.

Issues an order in regard to the duties of petty governors. Madrazo and Malcampo pursue the pirates with good results. The conference of San Vicente de Paul is established. The printing Antes Acordadas is authorized.

DON JOSÉ LEMERY.

1861-1862.

1861. The official bulletin of the Philippines takes the name of the Manila Gazette, by royal order of the previous year. A politico-military government is established in Visayas, and another in Mindarao. The beginning of work of coining in the mint of Manila. The School of Botany and Agriculture is established. The Jesuit priests begin anew the evangelization of Mindanao, establishing themselves in Polloc. Some gunboats with hulls of steel and light draft arrive in the islands and begin a vigorous and successful campaign against the pirates. Mendez Nunez, Malcampo, Maldrazo, and Munoz distinguish themselves.

(Interregnum.)

DON SALVADOR VALDES.

1862.

Lemery sets sail for the Peninsula on the 7th of July. The segunda cabo, Don Salvador Valdes, takes charge of the government until the ninth month, when the proper governor arrives.

DON RAFAEL ECHAGUE.

1862-1865.

1862. During this administration the archipelago is afflicted by cholera, fire, flood, cyclones, and locusts.

1862. Feasts for the canonization of the martyrs of Japan. By royal decree a royal delegate is created to study the various branches of administration. Arrival in the islands of the Sisters of Charity and of the Friars of the Congregation of San Vicente de Paul. The gunboats continue the pursuit of the pirates.

1863. Creation of the minister for the colonies. Great earthquake, which almost reduces Manila to a mountain of ruins, with the death of 400 persons and the injury of some 2,000.

1864. The ayuntamiento founds a municipal school for girls in charge of the Daughters of Charity. Lightning sets fire to the general storehouse of tobacco, with a loss of $2,000,000. Traitorous conduct of the Dato Uto in the Rio Grande de Mindanao.

1865. Solemn inauguration of the normal school for (female) schoolteachers.

(Interregnum.)

DON JOAQUIN DEL SOLAR.

1865.

During this brief government various dispositions are made in regard to the new organization of the offices of the treasury department.

DON JUAN DE LARA.

1865-1866.

1865. A great fire destroys a large part of the suburbs of Tondo, Santa Cruz, and Quiapo. Lara takes the College of Santa Potenciana for the residence of the captain-general and transfers to the College of Santa Isabela the pupils of the College of Santa Potenciana. The bishopric of Jolo is established. The Pious School, in charge of the Jesuits, takes the name of Ateneo Municipal, and is acknowledged as an institute of secondary instruction. Demarcation of the troops of the governor in the Philippines and of the treasurer.

1866. Rules in regard to the taxation of the Chinese. Establishment of a government place of deposit. The Moros of Supangan and Symuay, who had risen in arms, are conquered.

(Interregnum.)

DON JOSE LAUREANO DE SANZ.

1866.

This government carried out the royal order for the creation of a general inspection of public works and the royal decree approving the organic laws of civil careers in the political administration of the colonies.

(Interregnum.)

DON JUAN ANTONIO OSORIO.

1866.

Sanz, being relieved of his position of segundo cabo, and it being near the time for the arrival of his successor, he embarks for Spain, leaving the command to the naval commander, Don Antonio Osorio, who governs for six days only.

(Interregnum.)

DON JOAQUIN DEL SOLAR (SECOND TIME).

1866.

A commission is named to study reforms in the penal code for the colonies. There is created in Manila a central committee of agriculture, industry, and commerce. The squadron of the Pacific proceeded from Callao and arrives in Manila.

DON JOSE DE LA GANDARA.

1866-1869.

During this administration many improvements are made in Manila and its suburbs.

1866. Various royal orders arrive concerning the treasury, justice, militia, public works, etc.

1867. The College of San Juan de Letram, in charge of the Dominican Friars, is declared a college of secondary instruction. Great floods in Manila and in Ilocos. Loss of the steamer *Malaspina* on its return from Hongkong.

1868. Establishment in Nueva Caceres of the College of Santa Isabel, in charge of the Daughters of Charity. An expedition for the punishment of certain wrongs committed by the savages of the provinces in the north of Luzon.

1869. Establishment of the guardia civil.
(Interregnum.)

DON MANUEL MALDONADO.

1869.

Discharges for one month the office of governor. Nothing of importance occurs during this time.

DON CARLOS DE LA TORRE.

1869-1871.

1869. The Governer-General suppresses the alabarderos who served in the palace. The pardon of criminals and the formation from them of the company of Guias de la Torre (Guides of the Tower) to pursue criminals: an unfortunate measure, which multiplied crimes and disturbances. A committee formed by the governor takes possession of the funds of the College of Santa Isabel. The governor commands the destruction of the statue of Isabel II in the Orroceros; orders the proscription of Spaniards from the Peninsula. Inauguration of the Canal of Suez.

1870. Several hundred vagabonds are deported to Balabac and Mindanao. The rebuilding of the cathedral, ruined by the earthquake of 1863, is begun. The remains of Anda are transferred to the Church of the Third Order of San Francisco.

1871. De la Torre attempts to carry out the orders of the minister of the colonies, Señor Moret, secularizing the University of Secondary Education. Suspension of these orders.

DON RAFAEL IZQUIERDO.

1871-1873.

1871. Eruption of the volcanoes of Camiguin and of Mayon. Circular concerning the obligation of the Indians to take out personal cedulas. The gunboats destroy several pirate boats and burn towns.

1872. A vast conspiracy, which fails in Manila and is transferred to Cavite, is controlled in two days. Navy regiment of artillery is disbanded and a regiment of Peninsula artillery arrives. The King of Camboja, Norodom I, first visits Manila. The veterans' civil guard for public vigilance and services in Manila and its suburbs is established. Tornado in Manila. A politico-military government is established at Paragua, in

Zamboanga. Seventy prisoners rise and are scattered and followed, not alone by the troops of the garrison, but also by the people of the town. The electric semaphor line from Manila to Punta Restinga is established.

1873. A telegraphic line is established in various provinces of Luzon.

(Interregnum.)

DON MANUEL MacCROHON.

1873.

During the sixteen days of his command nothing worthy of mention occurs.

DON JUAN ALAMINOS.

1873-1874.

Alaminos attempts to establish in his diocese the presbitero of Alcala-Zamoro, presented by Ruiz Zorrilla for the bishop of Cebu, but he had been refused by the Holy See. He recedes from his position before the energetic conduct of the archbishop. He interfered also without reason with the Daughters of Charity, whom he threatened to send to Spain. In the mountains of San Mateo and Boboso there were various encounters between the civil guards and the bandits. A line of Spanish steamers is established between the archipelago and the peninsula. The ports of Legaspi, Tacloban, and Leyte are opened to commerce.

(Interregnum.)

DON MANUEL BLANCO VALDERRAMA.

1874.

Five hundred Moros from Jolo attack the garrison in Balabac and are repulsed.

DON JOSE MALCAMPO.

1874-1877.

1875. Inauguration of the bridge of Spain. Proclamation of Alfonso XII, King of Spain.

1876. Concurrence of the Philippines in the exposition at Philadelphia. Conquest of Jolo. Construction of fortifications for the preservation of the conquered country. Don Pascual Cervera remains in Jolo as governor.

1877. The statue of Isabel II is replaced in Arroceros. A number of artillerymen rise against their colonel, and the segunda cabo returns them to their barracks.

DON DOMINGO MORIONES.

1877-1880.

1877. Before installing himself in the palace Moriones goes to the artillery barracks, punishes the colonel in command, and goes immediately with him to visit the guilty ones. While being ——— the leaders of the riot are shot. Moriones represses usury; orders the payment to collectors of tobacco tax the amount that is due them; convokes meeting of medical men to better the hygienic conditions of Jolo. A most useful expedition under Gamir goes to Jolo and explores part of the island.

1878. Inauguration of the waterworks system of Carriedo. Promulgates in these islands a reduction of the number of feast days, as indicated by the Pope. Moriones goes on an expedition to the south of the archipelago. The Sultan and the datos of Jolo sign articles of capitulation, acknowledging the rights of Spain.

1879. Feasts were celebrated in the Philippines for the second marriage of the King to Donna Maria Cristina.

(Interregnum.)

DON RAFAEL RODRIGUEZ ARIAS.

1880.

Organizes the committee of works of the port of Manila.

DON FERNANDO PRIMO DE RIVERA.

1880-1883.

Strong earthquake in Manila. Cable communication between Luzon and Spain established.

1881. Royal decree does away with the tobacco monopoly. Various measures are taken for the reduction of the individuals of the north of Luzon as a result of a visit which Primo de Rivera had made to those provinces. By royal decree general inspection of communications is established. Expedition to Paulin to punish the Moros of Jolo. A garrison is reestablished at Siassi, Tataan, and Bongao. Strong tornado, whose vortex passes over Manila. Cholera in Zamboanga and in Manila. Savings bank is established, and the waterworks system initiated by Moriones is inaugurated.

1883. The Philippines are represented in the exposition of Amsterdam.

INTERREGNUM. DON EMILIO MOLINS.

1883.

During the few days of this government nothing important occurs.

DON JOAQUIN JOVELLAR.

1883-1885.

1883. Reduction from forty to fifteen days in the work required by the state from each person, and the placing of a provisional tax of $1.50 on each person. The general plan for railroads in Luzon is approved.

1884. Jovellar makes a visit to the islands of the south; institution of the personal cedula. Reforms in the general direction of civil administration. Observatory under the care of the Jesuits in Manila is declared official. Newly converted infidels in Mindanao are made exempt from tribute for life.

INTERREGNUM. DON EMILIO MOLINS (second time).

1885.

During the three days he was in office nothing occurred worthy of mention.

DON EMILIO TERRERO.

1885-1888.

1885. Danger of conflict between Spain and Germany in respect to sovereignty over the islands known as the Carolines. News of the death of the King, Don Alfonso XII.

1886. Termination of the conflict between Spain and Germany in regard to the Carolines and Palaos, by the arbitration of Pope Leo XIII. Birth of Alfonso XIII. Missionary work in the Carolines and Palaos is intrusted to the Capuchin friars. Successful expedition of Don Julio Seriña against the Dato Uto. The Dato Harun goes to Manila and is proclaimed sovereign of Jolo.

1887. Commencement of work on the railroad from Manila to Dagupan. Terrero begins an expedition against the Dato Uto, who is established on the Rio Grande in Mindanao; he establishes himself at Bacat, breaking the powerful influence of the Moro Dato. Glorious expedition to Maibung. Destruction of the fort of the rebel sultan. Other successful expeditions to Tapul, Pata, Boal, etc.

1888. Political manifestation, Masonic and antipatriotic, prohibited by certain friends of Terrero, this being the motive for relieving this governor.

INTERREGNUM. DON ANTONIO MOLTO.

1888.

The segundo cabo, Don Antonio Molto, on account of sickness gives up his charge of commander of the navy.

INTERREGNUM. DON FEDERICO LOBATON.

1888.

This governor takes command on the evening before the arrival of the new governor-general,

DON VALERIANO WEYLER.

1888-1891.

1888. Weyler reestablishes the order disturbed in the last days of Terrero. The tramway from Manila to Malabon is inaugurated.
1889. The agricultural school is established in Manila. Registry of property is also established.
1890. The organization of Ayuntamientos is begun in the capital towns and provinces under civil government. The School of Practical and Professional Arts and Trades is established. Telephone system inaugurated in the Philippines. Defenses of Tucuran, in Mindanao, are terminated.
1891. Inauguration of the railroad from Manila to Calumpit. Campaign against the Moros of Lake Lanao. Colonel Huerba, with an expedition, arrives at said lake and takes possession of Fort Marahui and returns to the general barracks at Iligan. At Dagupan, in the province of Pangasinan, a college of the first class of secondary education is established under the care of the Dominicans.

DON ULOGIO DESPUJOL.

1891-1893.

1892. Inauguration of the railroad from Calumpit to Dagupan. Establishment of a higher normal school for (female) teachers, under the direction of the Agustins of the Asuncion. Despuhol visits the southern part of the archipelago. He makes a new classification of schools and obtains an increase of pay for male and female teachers and the assignments of material for schools. He pardons various men who had been deported. Celebration of the fourth centennial of Christopher Columbus.

DON FEDERICO OCHANDO.

1893.

Nothing important happens during this short administration.

DON RAMON BLANCO.

1893-1896.

1893. By royal order municipal laws in the provinces of Luzon and the Visayas are modified according to the so-called reforms of Maura. In Jolo the Sultan Harun abdicates, and the Dato Amirul Quiram is proclaimed in his stead.
1894. Campaign against the Moros in the north of Mindanao.
1895. Opening of the first regional exposition of the Philippines. Electric light is established in Manila. Larabui, of Lake Lanao, is captured. The first mission of the Benedictine friars arrives in the Philippines.

1896. P. Mariano Vil, an Agustin, denounces to the authorities, with clear proofs, a conspiracy that is about to be carried out. The revolution is established; conflicts take place in the vicinity of Manila; publication of an amnesty; the rebellion extends to the neighboring provinces to Manila; insurrections discovered and suppressed in Jolo and Paragua. In Iligan two companies of convicts rebel, and these afterwards infest the towns of the north of Mindanao. Reenforcements arrive from Spain. Inaction after the defeat of Noveleta. Blanco is relieved.

DON CAMILIO POLAVIEJA.

1896-1897.

1896. Polavieja takes command the 12th of December and begins operations against the rebels. The military courts become very active, and many Filipinos held as authors of the conspiracy are executed, among them Rizal.

1897. A combined attack by six columns against the place known as Cacaroon de Sile breaks the insurrection in the province of Bulacan. Fresh reenforcements arrive from Spain. The execution of Filipinos continues, and conflicts take place in the provinces of Manila, Bataan, Pampanga, and Batangas. Publication of an amnesty; regiments of native volunteers are organized; the conquest of the province of Cavite is begun; the taking of Silang, Dasmarinas, Imus; granting of another amnesty; taking of Noveleta and San Francisco de Malabon.

INTERREGNUM. DON JOSE DE LACHAMBRE.

1897.

Operations were suspended during the brief administration of Lachambre.

DON FERNANDO PRIMO DE RIVERA.

1897-1898.

1897. Primo de Rivera makes addresses to the people and to the army and begins operations. Taking of Indang, Maragondon. Publication of amnesty. Various garrisons are established. Negotiations for peace treaty of Biac-nabato. Aguinaldo and various chiefs are deported to Hongkong, where Aguinaldo collects the $400,000 on the check of the Hongkong bank which was given him. Earthquakes in Mindanao and Jolo. Terrible tornado in Samar and Leyte.

1898. A Te Deum is sung in the Philippines and in Spain for the peace. Some uprisings in Luzon.

DON BASILO AUGUSTIN.

1898.

Conferences between Aguinaldo and the consul-general of the United States in Singapore. The American squadron destroys the Spanish squadron in the Bay of Manila. Blockade of Manila. Americans bring Aguinaldo and other chieftains from Hongkong to Cavite. Organization of the Philippine militia. Organization of the advisory assembly of the Philippines and publication of a programme of autonomy. Uprising in the provinces of Luzon, and the assassination of the defenseless Spaniards. Various garrisons fall into the power of the Tagalogs. A squadron under the command of Camara starts from Spain, but returns after having passed through the Suez Canal.

INTERREGNUM. DON FERMIN JAUDENEZ.

1898.

Preliminaries of peace. Capitulation of Manila. Americans enter Manila.

INTERREGNUM. DON FRANCISCO RIZZO.

1898.

Don Jaudenez leaving for Spain, General Rizzo remains in command. Nothing important happens during his administration.

DON DIEGO DE LOS RIOS.

1898-1899.

1898. Rios established in Iloilo. Continues the government of those islands where the Spanish flag still flies. A small Tagalog fleet is destroyed by some Spanish gunboats. By the treaty of Paris the Philippines cease to belong to the Crown of Spain and pass into the power of the United States. Rios orders fortresses to be abandoned and troops to be concentrated in Zamboanga. From there he returns to Manila.

1899. Rios arrives in Manila the 1st of January. Embarkation of Spanish troops for the Peninsula. Rios returns to Spain, and General Jaramillo remains as president of the commission for the selection and transportation of material of war. Don Manuel Sasbron at the head of the commission in charge of Spanish property in the Philippines.

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